

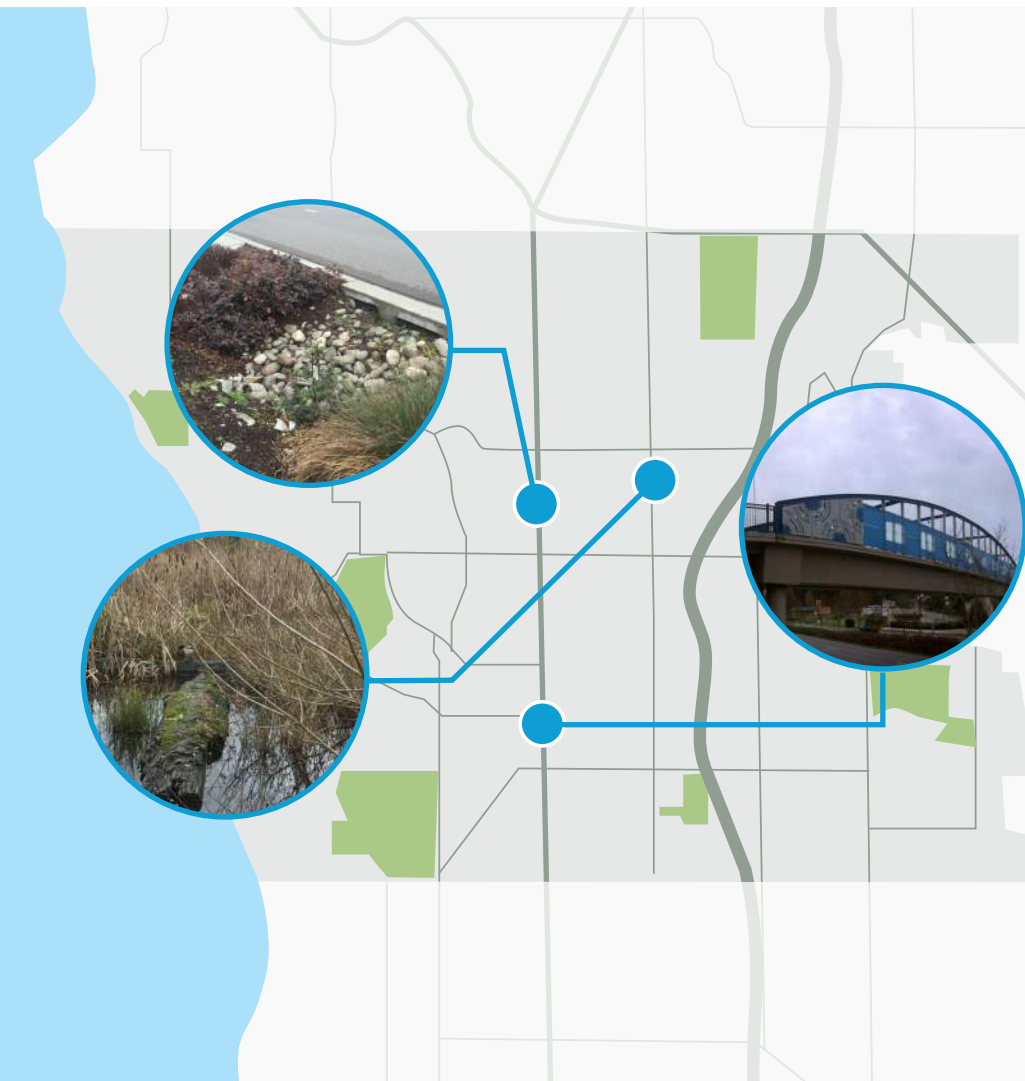
Prepared for **City of Shoreline**

VOLUME 3 // APPENDICES G-L

Surface Water Master Plan



October 2018



PARTNERING WITH:



Appendix G: O&M Manual

City of Shoreline

Surface Water Operations and Maintenance Manual

Prepared for
City of Shoreline, Washington
October 25, 2018

FINAL



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List of Abbreviations

2014	
SWMMWW	Stormwater Management Manual for Western Washington
BMP	best management practice
CB	catch basins
CCTV	closed-circuit television
CEMP	comprehensive emergency management plan
CIP	capital improvement project
CIPP	cured-in-place pipe
City	City of Shoreline
CMMS	computerized maintenance management system
CMP	corrugated metal pipe
CRT	Customer Response Team
EAP	emergency action plan
Ecology	Washington State Department of Ecology
EDM	Engineering Development Manual
ELM	equipment, labor and materials
ESA	Endangered Species Act
ft	foot/feet
ft ²	square foot/feet
ft ³	cubic foot/feet
GIS	geographic information system
HPA	Hydraulic Project Approval
IDDE	Illicit Discharge Detection and Elimination
in.	inch(es)
in. ²	square inch(es)
LOS	level(s) of service
Manual	Operations and Maintenance Manual
MHz	megahertz
MS4	municipal separate storm sewer system
N/A	not applicable
NASSCO	National Association of Sewer Service Companies
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
O&M	operations and maintenance
PACP	Pipeline Assessment and Certification Program
PPE	personal protective equipment
R/D	retention / detention
R&R	repair and replacement
RCW	Revised Code of Washington
Regional Road Guidelines	Regional Road Maintenance Endangered Species Act (ESA) Program Guidelines
ROW	right-of-way
SMC	City of Shoreline Municipal Code
SOP	standard operating procedure
SWES	Surface Water and Environmental Services
Utility	Surface Water Utility
WDFW	Washington Department of Fish and Wildlife

Section 1

Introduction

This Operations and Maintenance (O&M) Manual (Manual) is intended to inform and provide guidance to Surface Water Utility (Utility) staff and contractors responsible for maintaining and operating the City of Shoreline's (City) municipal stormwater system. The contents of this Manual will help O&M staff make Shoreline a safe and vibrant community. The procedures and processes contained in this Manual will help provide consistent, predictable levels of service (LOS) for Utility customers and protect City stormwater and environmental resources.

This Manual is organized by the various stormwater system asset and maintenance activity types. It presents maintenance practices and processes for Utility maintenance staff and contractors to help:

- Promote worker safety
- Prioritize and schedule needed maintenance activities
- Comply with federal and state requirements
- Achieve adopted performance standards and LOS
- Manage Utility assets
- Protect aquatic environmental resources
- Provide the City capital improvement projects (CIPs) and repair and replacement (R&R) programs with information regarding needed stormwater system improvements

This Manual may be referenced in answering questions regarding the Utility's operating obligations and processes. There are also associated documents to assist Utility maintenance staff and contractors performing stormwater system maintenance. Other supporting documents are referenced throughout this Manual.

This Manual should be updated as operations needs change to address new regulations, changing field conditions, new policies, or other changes affecting stormwater O&M activities. This document should be revised through a process of continuous improvement to ensure utilization of best practices. The information and processes contained in this Manual should be evaluated for efficiency and effectiveness in achieving desired results, and be evaluated against organizational goals. A review of this Manual should occur on a regular basis, and with any significant regulatory or policy change having the potential to affect stormwater operations or systems. Included in the preliminary portion of this document is a versioning section that includes space for the reason, date, and type of updates completed.

1.1 Purpose of the Manual

This Manual is intended to guide Utility staff in meeting stormwater systems O&M requirements under the *Stormwater Management Manual for Western Washington* (2014 SWMMWW) and National Pollutant Discharge Elimination System (NPDES) Phase II permit. It also will assist staff in complying with the requirements of the City of Shoreline Municipal Code (SMC), and adopted Utility LOS.

The City maintains and operates a municipal separate storm sewer system (MS4) and discharges to streams, lakes, wetlands, and the Puget Sound. The City MS4 includes ditches, detention ponds, catch basins, pump stations, filters, and other stormwater system components in addition to various

types of storm drainage pipes. This Manual provides guidance in operating and maintaining these system components to meet regulatory requirements, control flooding, and reduce downstream impacts to aquatic habitat, fish, and wildlife outside of the MS4.

In addition to the NPDES Phase II permit maintenance standards and requirements, the Utility must also obtain and maintain a Hydraulic Project Approval (HPA) permit from the Washington Department of Fish and Wildlife (WDFW) for certain types of maintenance work. Construction projects or activities including routine maintenance work in or near waters of the state must be executed under the HPA. This Manual indicates which maintenance activities may trigger an HPA.

1.2 Purpose of Maintaining Stormwater Assets

Along with controlling flooding and properly maintaining stormwater system components, asset maintenance helps reduce surface water and groundwater pollution. Storm drainage maintenance is necessary to protect streams, lakes, wetlands, and groundwater.

Proper maintenance helps ensure that:

- Stormwater system components operate as they were designed to protect the public and environment from flooding and water pollution
- Stormwater system components are cleaned of pollutants, such as sediment and oils, so that those materials are not deposited into streams, lakes, and the Puget Sound
- Stormwater system pollutant removal capacity is not overwhelmed, with the system then becoming a source of pollutants
- Beneficial plant health and weed control within vegetated stormwater facilities

1.3 Reference Documents and Manuals

Reference documents and manuals used in the creation of this Manual include:

- *Western Washington Low Impact Development (LID) Operation and Maintenance (O&M)* (Herrera and Washington Stormwater Center 2013)
- *2016 Engineering Development Manual (EDM)* (City 2016)
- 2014 SWMMWW, including Volumes IV and V, which address maintenance intervals and best management practices (BMPs) during and post-construction (Ecology 2014)
- *Regional Road Maintenance Endangered Species Act Program Guidelines* (Regional Road Guidelines), which provide information for BMP use relating to road maintenance and Endangered Species Act (ESA) compliance (Tri-County Working Group 2000)
- *Cityworks Supplemental Training Manual* (Woolpert 2013)

1.4 Maintenance Zones

The Utility uses a maintenance map to divide the city into smaller sections. These zones are referenced as part of the inspection interval and portioning work. The Street Operations Division also uses this system, which helps to enhance greater communication between groups. See Figure 1-1 below for a depiction of City maintenance zones.

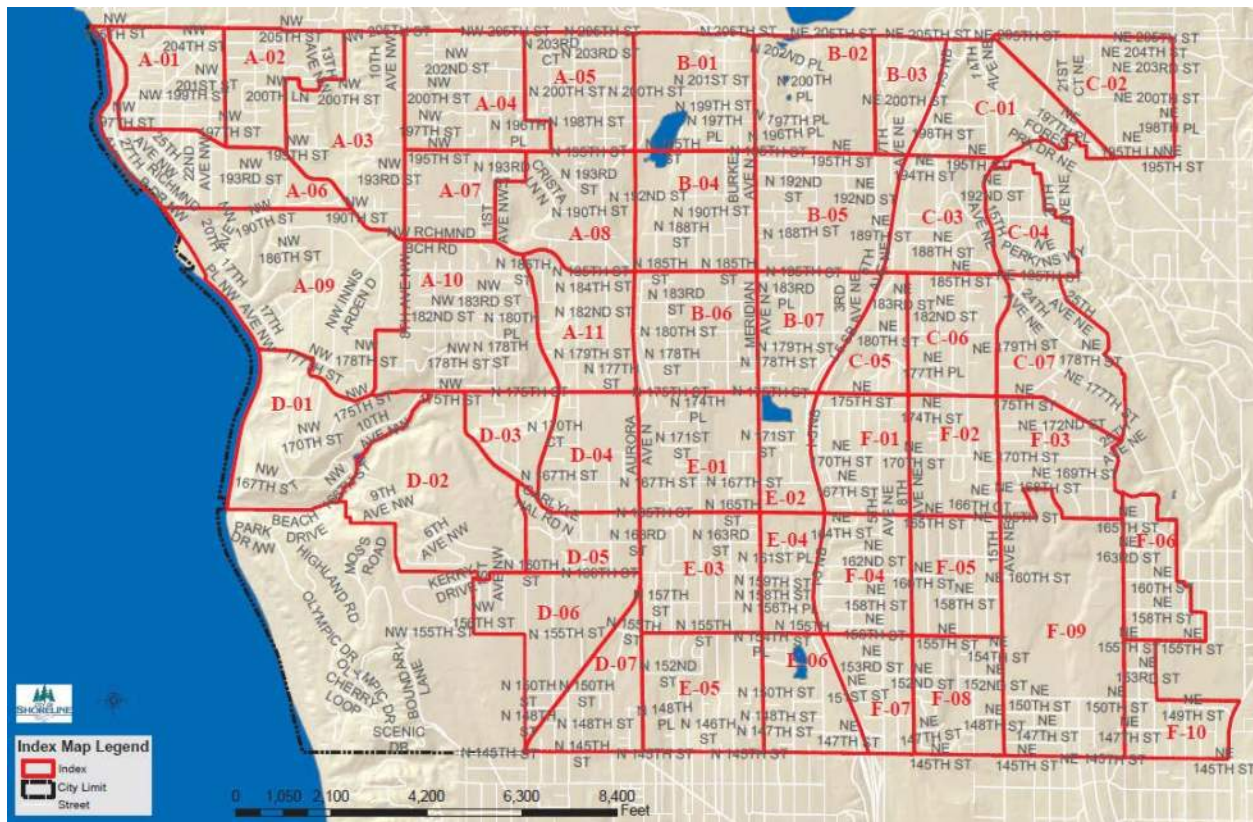


Figure 1-1. City Public Works maintenance zones

1.5 Stormwater Asset Inspection Program

The Utility's stormwater asset inspection program is designed to inspect surface water assets and facilities according to the *Stormwater Management Manual for Western Washington* (SWMMWW) and to meet the NPDES Phase II permit through the following programs:

- Right-of-way (ROW) inspections include catch basins, ditches, and ditch adjacent pipe (driveway culverts) networks that transfer surface water from ROW pavement. Each catch basin is inspected on a biennial cycle while each ditch is inspected every third year.
- Regional facility inspections involve visual checks of all stormwater infrastructure, access, and safety features associated with a regional site owned and operated by the City. The extent of infrastructures included in each regional facility is defined in a geographic information system (GIS) polygon shape.
- Residential facility inspections involve visual checks of all stormwater infrastructure on a biennial cycle (once every other year). Half of the facilities are inspected on even years and the other half are inspected on odd years.
- Commercial/private facility inspections involve visual checks of all stormwater infrastructure on privately owned sites on an annual or biennial cycle (depending on inspection history).
- Pipe and structure inspections include inspection of pipe and structures through closed-circuit television (CCTV) and handheld recording devices on a basin-wide scale on a 20-year frequency.

Table 1-1 presents the types of stormwater assets associated with each inspection program and the inspection frequency

Table 1-1. Surface Water Asset Inspection Program Summary

Inspection Program	Asset	Frequency of Inspection
ROW	Catch basins	Every 2 years (1/2 annually)
	Pipes (adjacent to ditches)	Every 3 years (1/3 annually)
	Ditches	Every 3 years (1/3 annually)
Regional Facilities	<ul style="list-style-type: none"> Catch basins/manholes Ponds, tanks, constructed wetlands, pump stations, infiltration facilities Culverts, natural channels, pipes Filterra, vaults, gauges, filters, gate valves, pipe 	Annually
Residential Facilities	<ul style="list-style-type: none"> Catch basins/manholes Facilities (ponds, tanks, pump stations) 	Biennially
Commercial/Private Facilities	<ul style="list-style-type: none"> Catch basins/manholes Ponds, vaults and tanks, bioretention 	Annually or biennially (depending on inspection history)
Pipe and structures	<ul style="list-style-type: none"> Pipe Manholes 	At least every 20 years
Hot spot locations	Facilities (pump stations, flooding locations)	Weekly (October-February) After major storms (March-September)

The components of the ROW, regional, residential, and commercial/private facility inspections are scheduled throughout the year as shown in Table 1-2, though inspection scheduling may be modified to address changing field conditions.

Table 1-2. Estimated Annual Inspection Scheduling

Inspection Type	Start	Finish
City and Park Facility	January 1	January 31
ROW Catch Basin	February 1	April 29
ROW Ditch	May 1	May 31
Commercial/Private Facility	May 1	August 31
ROW Pipe (adjacent to augured ditches only)	July 1	July 31
Regional Facility	August 1	August 31
Residential Facility	September 1	September 30

The Utility records all work performed on an asset in the Cityworks computerized maintenance management system (CMMS). A CMMS is a software package that maintains a computer database of information about an organization's maintenance operations. Cityworks is used to track work orders, inspections, and service requests related to assets. Cityworks can also be used to track work done at addresses, locations, and non-asset-specific work.

All work performed on assets (e.g., preventive, corrective, reactive, and predictive) is recorded in Cityworks. Equipment, labor, and materials are entered to varying degrees; contractor costs are entered as a lump sum; and equipment (truck) usage is logged for work orders when used. Refer to the *Cityworks Supplemental Training Manual* on procedures for recording work and inspections (Woolpert 2013). Inspection tables included in this Manual are representations of the CMMS inspection checklists.

1.6 Construction and Operations Water Quality BMP

The Utility references the Regional Road Guidelines as a primary source of construction BMPs for each asset type. When performing maintenance, repair or replacement activities, City staff should consider the use of the water quality BMPs based on the size and extent of the work type. Each asset maintenance description will include a reference to the most commonly used BMPs and the associated number within the Regional Road Guidelines for the maintenance/installation of an asset (Tri-County Working Group 2000).

1.7 Asset O&M Activity Summary

Table 1-3 provides a summary for the assets included in this O&M Manual.

Table 1-3. O&M Summary by Asset					
Manual Section	Asset	O&M Activity	Accomplished by	Frequency	Timing
4.1	Bioretention	Inspection	City	Annually	August
		Maintenance	Contractor	Annually	February - December
4.2	Catch basin	Inspection	City	1/2 annually	February-April
		Vactoring	Contractor	Annually	March-November
		Repair/Replace	City/Contractor	Annually	Year round
4.3	Constructed Wetland	Inspection	City	Annually	August
4.4	Control structure	Inspection	City	Annually	Varies based on inspection program
4.5	Culvert	Inspection	City	Annually	Varies based on inspection program
4.6	Dam	Inspection	City/Ecology	Annually	August
4.7	Ditch	Inspection	City	1/3 annually	May
		Maintenance	City/Contractor	Annually	July
4.8	Drain	Inspection	City	Annually	Varies based on inspection program
4.9	Filter	Inspection	City	Annually	August
4.10	Filterra	Inspection	City	Annually	August
4.11	Floodwall	Inspection	City	Annually	August
4.12	Gate valve	Inspection	City	Annually	August
4.13	Gauge	Inspection	City	Annually	Varies based on inspection program
4.14	Hydrodynamic separator	Inspection	City	Annually	Varies based on inspection program
4.15	Infiltration Pipe	Maintenance	Contractor	Biennially	June
4.16	Manhole (part of other inspection)	Inspection	City	Annually	Varies based on inspection program
4.16	Manhole (condition assessment)	Inspection	Contractor	Every 20 years	Varies based on inspection program
4.17	Media filter drain	Inspection	City	Annually	August
4.18	Natural channel	Inspection	City	Annually	Varies based on inspection program
4.19	Oil/water separator	Inspection	City	Annually	Varies based on inspection program
4.20	Outfall	Inspection	N/A	Annually	Varies based on inspection program
4.21	Permeable pavement	Inspection	City	Annually	Varies based on inspection program

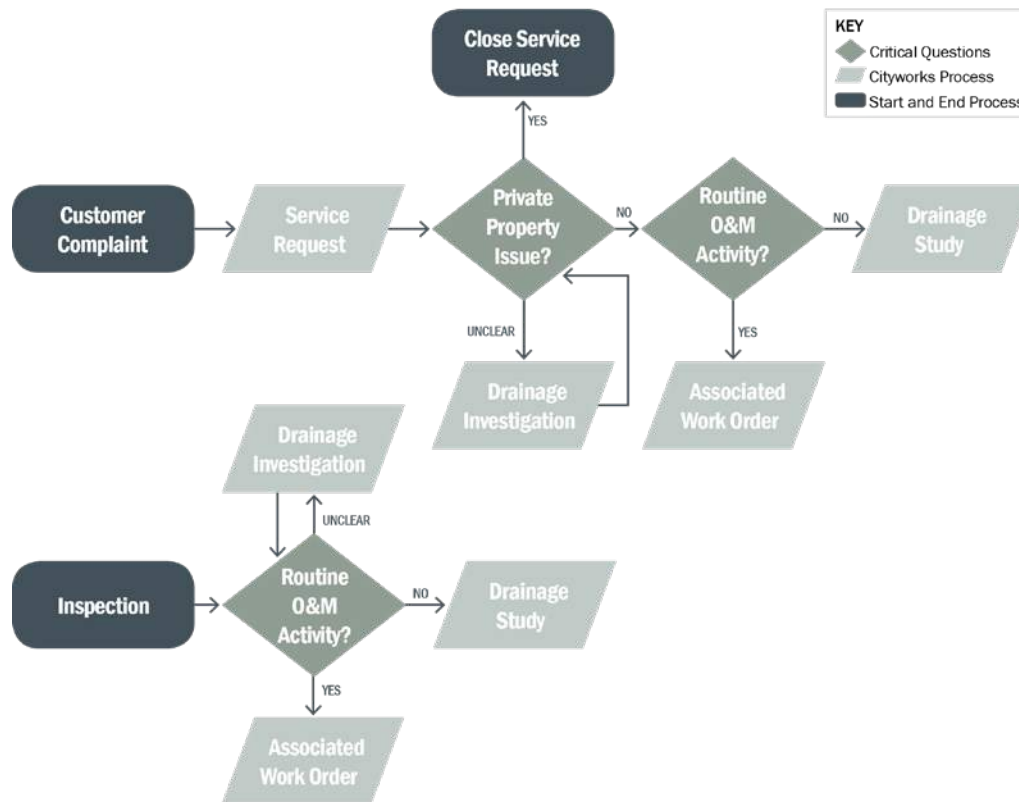
Table 1-3. O&M Summary by Asset

Manual Section	Asset	O&M Activity	Accomplished by	Frequency	Timing
4.22	Pipe (part of inspection program)	Inspection	City	Annually	Varies based on inspection program
	Pipe (part of ditch inspection)	Inspection	City	Annually	July
	Pipe (part of ditch inspection)	Maintenance	Contractor	Annually	August-September
	Pipe (condition assessment)	Inspection	Contractor	Every 20 years	varies
4.23	Pipe inlet structure	Inspection	City	Annually	Varies based on inspection program
4.24	Pond	Inspection	City	Annually	Varies based on inspection program
4.25	Pump station	Hot spot	City	Weekly	October - February
		Regional inspection	City	Annually	Varies based on inspection program
4.26	Stormwater facility	Inspection	City	Annually	Varies based on inspection program
		Maintenance	City/Contractor	As-Needed	March-October
4.27	Swale	Inspection	City	Annually	Varies based on inspection program
4.28	Vault and tanks	Inspection	City	Annually	Varies based on inspection program
		Maintenance	Contractor	Annually	Varies based on inspection program
5.6	Ronald Bog	Hot spot	City	Weekly	October - February
		Regional inspection	City	Annually	Varies based on inspection program

Section 2

O&M Work Flow Process

The work and workflow process for surface water O&M activities are tracked in Cityworks are illustrated in Figure 2-1.



Private property issue? -

Questions to determine if private property or Utility (ROW) issue

- I. Does this issue originate from a private property and only impacts private property? If yes, then it is a private property issue, inform the private property and close out Service Request
- II. Does the issue originate from a private property and impacting the ROW, if Yes then it is unclear who is responsible for resolving the issue, generate a Drainage Investigation work order
- III. Does the issue originate from ROW and impacting private property? Yes, it is not a private property issue, it is a ROW issue

Routine O&M Activity?

- I. Can the issue be resolved with routine operations and maintenance activity i.e vector, repair, replacement etc? if yes, then generate associated work order
- II. Does the issue require additional analysis, if yes, then generate a drainage investigation
- III. Does the issue require engineering analysis or activity beyond the O&M? if yes then generate a Drainage Study Work order

Drainage Investigation – Work Order to determine

- I. Responsibility- if the Utility or Private Property is responsible
- II. Cause - The cause of the issue
- III. Resolution - Type of work to resolve the issue i.e O&M activity, Repair, replacement, engineering analysis

Figure 2-1. Work and workflow processes for surface water O&M activities

A summary of key activities presented in Figure 2-1 is provided below:

- Surface water staff respond to Customer Complaints related to surface water or storm water issues, including flooding, water quality or poor drainage. Upon receiving resident complaints, staff create a service request to track and document the complaints and associate activities. Most service requests related to the public infrastructure or ROW assets are followed-up with a field investigation. Some customer/ residents' complaints are related to private property issues and may require a field investigation to verify that the issue is not related or caused by the public or ROW system.
- Service Requests are used to track complaints/requests for services that come in from citizens, contractors, or other employees. Requests consist of a problem code, incident location, caller information, response information, and related work activities. Service requests originate from a customer calling in with a complaint, a submittal from a public web portal, or from direct communication with city staff. For more details on service requests please refer to the 2015CityworksServiceRequests.docx included as Appendix A.
- Field Investigations are required for most citizens and customer complaints associated with public infrastructure. Document all findings during field investigation in the service request, including pictures. In most cases, the field investigation is completed and recorded in the service request. If a complete investigation could not be accomplished, then a drainage investigation will be created.
- Work Orders are used primarily to track work history against assets and the cost related to the work activities. Utility staff generate work orders for surface water assets. Work orders are either Reactive or Preventative. For more details on Work Order refer to the 2015CityworksWorkOrders.docx
- Drainage Investigations may include researching easements and historical data. Upon completing a drainage investigation, generate a work order to resolve the issue (e.g., cleaning or repair). If the issue resolution requires an engineering analysis, a Drainage Study work order is initiated and assigned to the SW Engineer
- Drainage Study work orders are for issues that require engineering analysis or additional analysis beyond typical operations and maintenance activities to resolve. This could include, issues related to lack of drainage infrastructures, capacity issues that require design of larger systems, significant erosion issues that require geotechnical analysis, etc.

Section 3

Version History and Potential Updates

The purpose of this section is to track the version history of the Manual and to summarize known potential updates to the O&M process and data management. Table 3-1 provides a location for Manual versions to be recorded with a change reference. Table 3-2 summarizes potential updates to the City data management systems (GIS and CMMS) or other O&M planning efforts by Manual section.

Table 3-1. Document Control

Date	Author	Version	Change Reference

Table 3-2. Asset SOP Status and Potential Updates

Manual Section No.	Asset SOP/ Manual Section Name	Existing Inspection provides Condition Assessment Data	O&M Manual Status	Cityworks Status	Potential Updates to City Data Management Systems
4.1	Bioretention	Yes	Inspection	Feature class	<ul style="list-style-type: none"> Update inspection form to indicate thin mulch is < 2 inches
4.2	Catch basin	Yes	Inspection	Feature class	-
4.3	Constructed wetland	No	Proposed Inspection	-	<ul style="list-style-type: none"> Develop a feature or object class Develop inspection form in Cityworks Add to regional inspection program
4.4	Control structure	Yes	Inspection	Object class	-
4.5	Culvert	No	New Inspection	Feature class	<ul style="list-style-type: none"> Add to regional inspection program
4.6	Dam	Yes	Inspection	Feature class	<ul style="list-style-type: none"> Link Dam design drawings to inspection form or provide direction 10% of pond filled with sediment for dam ponding area.
4.7	Ditch	Yes	Inspection	Feature class	-
4.8	Drain	Yes	Inspection	Feature class	-
4.9	Filter	No	Proposed Inspection	Object class	<ul style="list-style-type: none"> Develop inspection form in Cityworks Add to regional inspection program

Table 3-2. Asset SOP Status and Potential Updates

Manual Section No.	Asset SOP/ Manual Section Name	Existing Inspection provides Condition Assessment Data	O&M Manual Status	Cityworks Status	Potential Updates to City Data Management Systems
4.10	Filtterra	Yes	Inspection	Feature class	• Add plant health to inspection form
4.11	Floodwall	No	Proposed Inspection	Feature class	<ul style="list-style-type: none"> • Develop inspection form in Cityworks • Add to regional inspection program • Use geotechnical engineer in inspection process
4.12	Gate valve	Yes	Inspection	Feature class	• Add exercise valve criterion to inspection form or work order
4.13	Gauge	No	Proposed Inspection	Feature class	<ul style="list-style-type: none"> • Develop inspection form in Cityworks • Add to regional inspection program
4.14	Hydrodynamic Separator	No	Proposed Inspection	Object class	<ul style="list-style-type: none"> • Develop inspection form in Cityworks • Add to regional inspection program
4.15	Infiltration Pipe	No	Proposed Inspection	Feature class	• Obtain photo or schematic
4.16	Manhole	Yes	Inspection	Feature class	
4.17	Media filter drain	Yes	Inspection	Feature class	
4.18	Natural channel	Yes	Inspection	Feature class	
4.19	Oil/water separator	Yes	Inspection	Object class	
4.20	Outfall	Yes	Inspection	Feature class	• Add erosion/rock pad to inspection form
4.21	Permeable pavement	Yes	Inspection	Feature class	
4.22	Pipe	Yes	Inspection	Feature class	
4.23	Pipe inlet structure	Yes	Inspection	Feature class	
4.24	Pond	Yes	Inspection	Feature class	
4.25	Pump station	Partial	Hot Spot work order	Feature class	• Update Inspection form in Cityworks based on recommendations from CAMP
4.25	Pump station	Yes	Inspection	Feature class	
4.26	Stormwater facility	Yes	Inspection	Feature class	
4.27	Swale	Yes	Inspection	Feature class	
4.28	Vault and tank	Yes	Inspection	Feature class	

Section 4

Stormwater Assets: Standard Operating Procedures

This Manual provides descriptions of stormwater system maintenance work to be performed, including inspection, reporting, system cleaning, and repairs. For the purposes of this Manual, standard operating procedure (SOP) is defined to include not just facility operations, but inspection and maintenance procedures as well. This information is presented using:

- **Asset description:**
 - Associated SOPs are noted for drainage system components that may be associated with the work outlined in the section at hand
 - Asset photograph or sketch where available
- **Asset inspection:**
 - Inspection criteria provided for certain asset classes as appropriate, and indicating inspection frequency
 - Cityworks inspection tables provided where applicable to outline stormwater system inspection, and reporting criteria and results
 - Inspection general work method
- **Asset maintenance:**
 - Maintenance methods include SOPs and other considerations to be noted in performing maintenance
 - General work methods for routine and reactive maintenance activities
 - Washington State Department of Ecology (Ecology) maintenance tables included where applicable (from the 2014 SWMMWW) showing system component maintenance performance criteria for NPDES compliance
 - Construction BMPs providing references for construction activities as outlined in the Regional Road Guidelines (Tri-County Working Group 2000)

The SOPs for municipal stormwater system asset classes to which this Manual applies are provided below.

4.1 Bioretention Facility

A bioretention facility is an engineered facility that stores and treats stormwater by passing it through a specified vegetated soil profile for treatment, and typically retains or detains some volume of treated stormwater for flow attenuation.

Bioretention facilities provide water quality treatment through filtration and sediment deposition. Facilities are designed to retain surface water for up to 48 hours and provide some flow control.

Related SOPs include drains and swales. Figure 4-1 shows an example of a typical bioretention facility.



Figure 4-1. Bioretention facility

4.1.1 Bioretention Facility Inspection

Bioretention facilities are inspected annually, and typically in coordination with other assets associated with a regional inspection. Utility staff perform bioretention facility inspection and prepare corrective work orders for maintenance and R&R. Table 4-1 is a representation of the CMMS inspection checklist in Cityworks for bioretention facilities. The form is a simplification of Table V-4.5.2(21) Maintenance Standards – Bioretention Facilities”, Section 4.6, Volume V of 2014 SWMMWW, included in Appendix B.

Table 4-1. Bioretention Facility Cityworks Inspection Form with Inspection General Work Method			
Criterion	Result	Explanation	General Work Method
Sediment	FAIL	Present on curb cut or in lowest point in facility	Visual inspection on presence and location of the sediment
	PASS	Absent on curb cut and in lowest point in facility	
Vegetation	FAIL	Poor vegetation coverage or weeds present	Visual inspection, typical coverage for an established facility
	PASS	Adequate vegetation coverage and weeds absent	
Weeds	FAIL	Weeds present	The facility should be free of weeds such as grass, ivy, dandelions, or non-design/post-construction plantings that would reduce facility function
	PASS	Weeds absent	
Trash and debris	FAIL	Present	Visual inspection
	PASS	Absent	
Mulch	FAIL	Thin coverage	Visual inspection of less than 2 in.
	PASS	Adequate coverage	
Erosion	FAIL	Present on bank or in low point	Visual inspection of rills or channelization areas where mulch has been eroded away
	PASS	Absent on bank or in low point	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oil sheen or darkened mulch or soil from oil spill
	PASS	Oil/gas/other pollution absent	
Overflow	FAIL	Blocked or plugged	Visual inspection of overflow structure (beehive or grated inlet)
	PASS	Clear	
Under drain	FAIL	Blocked or plugged	Visual inspection into structure, look for standing water or debris
	PASS	Clear	
Curb cut	FAIL	Opening restricted	Visual inspection of curb cut, flow through cut and into facility should not be restricted
	PASS	Opening not restricted	
Other	FAIL	Other, comment	Other means any condition that requires attention to remain or be returned to operation
	PASS	None	

4.1.2 Bioretention Facility Maintenance

If a bioretention facility has a facility-specific O&M manual, refer to the facility manual for maintenance frequency and activities.

Table 4-2 summarizes bioretention facility maintenance.

Table 4-2. Bioretention Facility Maintenance Summary

Element	Description
Maintenance interval	Bioretention facilities shall be maintained monthly during the growing season (March–November).
Maintenance type/timing	<ul style="list-style-type: none"> Routine maintenance varies with the growing season and occurs as frequently as monthly. Several maintenance activities are especially prone to cause soil compaction; avoid compacting soil during maintenance activities. Typical routine maintenance includes removing weeds, removing trash, and adding mulch. See Table 4-3 for routine maintenance general work method. Perform corrective maintenance within 1 year of inspection. Typical corrective maintenance includes plant replacement and underdrain flushing. See Table 4-4 for triggered maintenance general work method.
Reactive maintenance	Maintenance efforts to address conditions such as damage from storms, car accidents, pollutant spills, or construction may require special repairs or cleanup.
Permit requirements	NPDES: Inspection must occur annually. If a bioretention facility does not meet a maintenance standard, general repairs must be made in 1 year and capital repairs in 2 years.

Table 4-3 lists general work methods for bioretention facility routine maintenance.

Table 4-3. Bioretention Facility Routine Maintenance General Work Method

Maintenance Activity	Recommended Frequency	Notes
Observation ports	<ul style="list-style-type: none"> Visually check observation ports at least 2 times per year. Check observation ports after 1 in. of rainfall in 24-hour period and record water level. 	<ul style="list-style-type: none"> Remove cap of observation port. Measure depth between observed water level and top of lid for port. Replace cap securely when done. Keep a record of measurements (including date) in maintenance log. Check project-specific O&M manual for minimum distance between top of observation port and water surface level during dry and wet weather. During rainy weather, ponding will occur in the bioretention and the water level will rise. After the rain event is over, the water level at the observation port should drop as the water drains out. If water does not drain out of the observation port after 72 hours after the rain event has ceased, or ponding at surface does not dry out in 48 hours, the bioretention system will require remediation. See “Ponding” in Table 4-4 on triggered maintenance for bioretention facilities.
Inspect inflow and outflow points for clogging	<ul style="list-style-type: none"> Monthly and as needed during wet season. 	<ul style="list-style-type: none"> If observed, remove sediment at surface, in pre-settling areas and at storm structure outfalls. Remove any accumulated debris from inflow/outflow points (e.g., curb cuts, pipes, trench drains, storm structures, etc.).
Cleanouts and underdrains	<ul style="list-style-type: none"> Visually check cleanouts and discharge points of underdrains pipes annually to determine if cleaning is necessary. 	<ul style="list-style-type: none"> Jet clean or rotary cut debris/roots from underdrains so that standing water is not present in pipes during dry weather.
Watering during 1st and 2nd growing seasons	<ul style="list-style-type: none"> In the first 6 weeks, plantings may require approximately 1 in. of water twice per week to establish deep roots. After watering, confirm that the soil is moist 3–6 in. below surface. Reduce watering frequency to once a week until the end of the first growing season (May–September). 	<ul style="list-style-type: none"> Intent of watering is to keep plant material sustained through establishment. Monitor rainfall to determine irrigation/watering schedule. Water regularly during the first 2 growing seasons. Dry periods will need additional watering for establishing plants because of warmer temperatures and increased sunlight, both of which can stress vegetation. Wilted leaves and drooping stems are all indications of stress caused by dry soils and hot temperatures. Optimal watering time is early in the morning or late in the evening to reduce evaporation. A preferred watering approach is to have repeated short cycles of watering and soaking into the ground. Follow manufacturer’s guidelines for O&M of irrigation system and its components.

Table 4-3. Bioretention Facility Routine Maintenance General Work Method

Maintenance Activity	Recommended Frequency	Notes
Dry period watering for established bioretention	<ul style="list-style-type: none"> Water infrequently but thoroughly: 0.5–1.0 in. every 2 weeks or when plants appear stressed. Monitor rainfall and check weather updates and adjust watering accordingly. 	<ul style="list-style-type: none"> Established (more than 2 years) drought-tolerant plants may need water during prolonged dry periods (possibly late July–mid-September). Inspect plantings during dry periods and look for signs of stress. Verify if any watering restrictions are in effect in the city for watering during dry periods/water shortages. If no restrictions, then note the following: Optimal watering time is early in the morning or late in the evening to reduce evaporation. Monitor rainfall to determine an irrigation schedule. Do not apply water faster than the soil can absorb it. Deeper and less frequent watering will encourage plants to develop a deep root system. If present, inspect irrigation system components for breaks and blockages and repair as necessary.
Leaf, branch, and organic matter removal	<ul style="list-style-type: none"> Inspect for organic matter or debris that are blocking inflow points or structures and causing ponding water. Schedule frequent leaf removal in fall. Frequent mowing may be required from spring–mid-July for turf bioretention. Monthly mowing may be required July–mid-November for turf retention. 	<ul style="list-style-type: none"> To prevent clogging, larger pieces of biodegradable landscape debris should be mulched or collected for composting, green waste pick up, or disposal to a recycling facility. Maintaining a minimum height of 4–6 in. for turf grass within bioretention facilities (turf) will reduce weed invasion and encourage deep root growth, which strengthens drought resistance. Mow with a mulch mower when grass is 10–18 in. or greater. Sharpen mower blades frequently to reduce ragged cutting. A thick layer of leaves, branches, and trash can prevent water and light from getting to lawn and other landscaped areas. Excessive leaf litter around plantings can provide cover for pests and allow mildew growth. Mulching organic matter (leaves) is recommended to facilitate decomposition for both turf and vegetated bioretention.
Trash and debris removal	<ul style="list-style-type: none"> Remove trash and debris. Inspect after large storm events (~more than 1 in. of rainfall in 24 hours or heavy downpour). 	<ul style="list-style-type: none"> Collect and properly dispose of trash/litter. Pet waste is a serious concern and should not be left within a bioretention facility as it contains disease-causing organisms and flushes bacteria into the stormwater.
Pruning and removal of dead material	<ul style="list-style-type: none"> In spring, remove dead or old plant material from previous season. Mid-summer and fall, inspect and cut back any plant material that blocks sidewalks and utilities. In fall, prune to maintain plant appearance. 	<ul style="list-style-type: none"> Trim and thin vegetation from prior season's growth, leaving 6–8 in. Allow dormant vegetation and old flower stalks to remain in winter to provide food and cover for birds. For early blooming shrubs/trees, prune in spring following bloom. Plants may require pruning, pinching, and dead heading during the growing season to promote reflowering, direct growth, etc. Native and/or ornamental grasses may appear dead but generally these plants are dormant during the winter months. Do not remove, prune dry material in spring as new material emerges. If appearing dead in mid-summer, remove and replace.
Weed control of invasive vegetation/weeds	<ul style="list-style-type: none"> Remove as soon as observed. During 3-year establishment period, inspect at least once per month in growing season. Inspect at least 3 times per year once plants are established. 	<ul style="list-style-type: none"> Pay special attention to nuisance and invasive vegetation before it establishes a foothold. Particular threats to wet areas are reed canary grass and Japanese knot weed. Other threats include clover, scotch broom, horsetail, morning glory, alder seedlings, English ivy, and blackberry. Watch for any signs of these plants and remove them, including the root system. See maintenance activity “Weed control of non-invasive vegetation/weeds” below for additional information. Persistent and invasive vegetation that is located in a mass can be killed by covering the area with black plastic for several weeks during summer. Disposal methods include bagging and dumpster disposal.

Table 4-3. Bioretention Facility Routine Maintenance General Work Method

Maintenance Activity	Recommended Frequency	Notes
Weed control of non-invasive vegetation/weeds	<ul style="list-style-type: none"> Inspect the full bed and remove weeds. Minor weeding monthly. See Mulch Maintenance Activity of this Table for more information to reduce weed establishment. 	<ul style="list-style-type: none"> Remove weeds manually before they go to seed by using pincer-type weeding tools, hoes, or hot water weeders. Remove the roots for best results. Weeds should be pulled when first observed and especially before going to seed. Weeds need to be pulled in early spring so that the desired plants can thrive. Mulch immediately (no more than 5 days) following weeding to improve weed control. When dealing with invasive plant material/weeds, attempt all other physical methods to remove before considering a more aggressive method. It is important to note that chemicals can harm or kill beneficial or desirable plants, and also add pollutants to stormwater that can negatively impact water quality.
Bare spots and vegetation removal and replacement	<ul style="list-style-type: none"> Inspect for bare spots and areas of disturbed vegetation every 6 months. 	<ul style="list-style-type: none"> Plants may die because of unsuitable conditions or microclimates, disease, pests, or other unforeseen issues. These plants must be removed/replaced to avoid the establishment of weeds in bare areas, the spread of disease, and the reduction in functionality. Reseed or replant bare areas and replace poor performing plants. Vegetation should cover 90% of bioretention. Replace vegetation with in-kind planting material or replace plants with high-mortality rate with appropriate plants. Maintain 1 ft zone clear of vegetation around all inlets and outlets.
Mulch	<ul style="list-style-type: none"> Add wood chip mulch in fall and/or spring, when necessary. Replace or add wood chip mulch as needed to maintain 2–3 in. depth. 	<ul style="list-style-type: none"> 1 cubic yard of mulch will cover 100 square feet at a depth of 3-inches. 1 cubic yard = 27 cubic feet. Commercial mulch products generally are available in 2 cubic foot bags. 13.5 bags = 1 cubic yard. Arborist wood chip, compost, and rock mulch helps to control weeds, conserve soil moisture, improve filtration, regulate soil temperatures, and adds nutrients to the soil as it decomposes. Apply wood chip mulch to slope and rim areas. Apply compost mulch to facility bottom and rock mulch for areas where high velocities may cause scouring.
Sediment removal	<ul style="list-style-type: none"> Late fall and late spring. After heavy downpour and rain events of 1 in. or more precipitation in 24-hour period. 	<ul style="list-style-type: none"> If more than 2 in. accumulation, remove sediment preferably when the bioretention facility/stormwater planter is dry. Remove sediment manually, using shovels or rakes. Dispose of sediment in accordance with local requirements. Replace damaged or destroyed vegetation with in-kind plant material.

Table 4-4 provides a general work method for bioretention-triggered maintenance.

Table 4-4. Bioretention Facility Triggered Maintenance General Work Method

Triggered Maintenance	Condition Observed	Instructions
Ponding water	<ul style="list-style-type: none"> Water is standing/ponding in bioretention and not draining within 48 hours after the rain event has stopped. The facility is not functioning properly due to blockage of sediment and/or debris in the soil strata, underdrain, or outlet structures. 	<ul style="list-style-type: none"> Check observation port to determine if underdrain pipe is blocked. Remove debris. Check surface overflow, outlet pipe, or structure to determine if blocked. Remove debris. May need vactoring. The soil may also be blocked by fine sediments. Rake mulch layer aside and remove sediment from top surface layer, aerate soil, and re-spread mulch.
Erosion of soils and sediment loading (attributable to temporary or extraneous conditions, not design defect)	<ul style="list-style-type: none"> 2 in. (or greater in depth) gullies/rills are present, washing out soils and mulch. Sediment washed downstream is clogging outlets and/or rock around outlet structures. 	<ul style="list-style-type: none"> Remove and store any desirable vegetation (to be used for replanting) from bioretention facility. Rake and remove fine sediments from surface. Add additional soil if necessary and regrade to direct water toward low point of bioretention, or level out bottom surface. Replant and/or replace vegetation and reapply mulch. If slopes have been compromised, remove vegetation (reserve for replanting), re-grade, and re-contour area by hand tools where practical. Replant vegetation and install 2–3 in. of mulch. Clear away rocks and sediment, and reinstall rock protection at structure inlets/outlets and add more rocks if needed.
Erosion of soils and sediment loading (attributable design defect)	<ul style="list-style-type: none"> Erosion is caused by concentrated flows entering the facility from the side, because of small variations in the impervious surfaces immediately adjacent the facility. 2 in. (or greater in depth) gullies/rills are present, washing out soils and mulch. Sediment washed downstream is clogging outlets and/or rock around outlet structures. 	<ul style="list-style-type: none"> Hand-install small rock protection features at the erosion location Remove and store any desirable vegetation (to be used for replanting) from bioretention regrade to direct water toward low point of bioretention, or level out bottom surface. Replant and/or replace vegetation and reapply mulch. If slopes have been compromised, remove vegetation reserve for replanting), re-grade, and re-contour area by hand tools where practical. Replant vegetation and install 2–3 in. of mulch. Clear away rocks and sediment, and reinstall rock protection at structure inlets/outlets and add more rocks if needed.
Soil settlement	<ul style="list-style-type: none"> Soil has settled 2 in. or more below paving surface. 	<ul style="list-style-type: none"> Rake mulch aside for later use. Apply prepared bioretention soil mix (use soil mix design per original plans if possible or see reference below for information) to bring soil height within 1–2 in. of top of pavement. Add 1–2 in. of mulch to bring top of mulch flush with adjacent paving/surface. Replant if necessary to provide vegetative cover over exposed soil.
Pest control	<ul style="list-style-type: none"> Pests have been reported to cause extensive plant damage or death and have/could become a nuisance or public health concern. Mosquitoes can breed in shallow stagnant ponding water. 	<ul style="list-style-type: none"> Remove all trash, fruit, and nuts that have fallen to the ground to avoid attracting rodents. Mosquito larvae look like “wiggling sticks,” typically floating perpendicular to water’s surface. Mosquitoes take 5–7 days to mature. Bioretention facilities are designed to drain out within 24–48 hours after the rain event has ceased. If stagnant ponding and larvae are observed, then remove ponding (see paragraph on ponding). Where rodent holes are present, fill with soil and lightly compact soil around the holes.

4.2 Catch Basin

A catch basin is a grated chamber or well, usually built along the runoff flow line of a street, for the admission of surface water to a storm pipe or subdrain, with a sediment sump at the base designed to retain grit and detritus below the point of overflow. The grit and detritus may contain pollutants that would otherwise discharge into downstream receiving waters.

Structures addressed in SOPs are those recorded in the City's GIS system as Type 1 and 2 catch basins and inlets. In the City's GIS, catch basins and inlets are included in the catch basin asset class. The manhole asset class erroneously includes Type 2 catch basins, which are inspected and maintained per this catch basin SOP.

An inlet is also a grated chamber that does not contain a sump, and is also maintained per this SOP. Many catch basins do not conform to the current standards for catch basin construction and dimensions. Some catch basins and inlets do not have a sump or may not have a bottom slab and are serving as drywells.

Related SOPs include control structure, manhole, and pipe. Figure 4-2 shows an example of the exterior of a catch basin.



Figure 4-2. Catch basin

4.2.1 Catch Basin Inspection

Catch basins and inlets must be inspected every 2 years per Phase II NPDES permit requirements. Basins must be cleaned, repaired, or replaced within 6 months of inspection that identifies the need to comply with maintenance standard unless the maintenance requires capital construction.

4.2.2 Catch Basin Inspection Procedure

Catch basin inspections require two staff members. Staff member one is responsible for driving the vehicle, routing, and completing the Cityworks Inspection Form. Staff member two is responsible for the visual inspection of the catch basin, which includes probing the catch basin for sediment depth. See Appendix C for a more detailed Catch Basin Procedure.

Table 4-5 is a representation of the CMMS inspection checklist in Cityworks for catch basins. The form is a simplification of Table V-4.5.2(5) “Maintenance Standards – Catch Basins”, Section 4.6, Volume V of 2014 SWMMWW, included in Appendix B.

Follow necessary safety and personal protection guidelines when inspecting, cleaning, and maintaining Type 2 catch basins. Type 2 catch basin inspections may require confined space entry.

Table 4-5. Catch Basin Cityworks Inspection Form with Inspection General Work Method			
Criterion	Result	Explanation	General Work Method
Sediment	FAIL	Sediment is greater than 60% depth of sump at lowest invert	Use graduated rod to estimate sediment depth and total depth from invert to sump bottom. Estimate percent depth of sediment.
	PASS	Sediment is less than 60% depth of sump at lowest invert	
Frame/slab	FAIL	Holes larger than 2.00 in. ² or cracks larger than 0.25 in.	Visual inspection of the frame and slab and use hole size guidelines to determine FAIL, CONCERN, or PASS. If the structure has issues but does not require immediate repair, select CONCERN.
	CONCERN	Holes between 1 and 2 in. or cracks greater than 0.125 in. and less than 0.250 in.	
	PASS	No holes larger than 1 in. ² and cracks larger less than 0.125 in.	
Walls/bottom	FAIL	Judgment that structure is unsound and needs immediate repair or replacement; function of basin is severely compromised	Visual inspection of walls and bottom concrete, missing bricks or large cracks. If bottom is covered with sediment, flag catch basin for inspection during cleaning.
	CONCERN	Judgment that there are structural issues but basin is functioning; may need minor repair	
	PASS	No structural issues; function of basin is sound	
Grout fillet (pipe to wall)	FAIL	Crack greater than 0.5 in. and longer than 1 ft with evidence of sediment entering	Visual inspection of the connection of pipes to catch basin or inlet wall. Visually estimate width and length or cracks with graduated rod or tape measure.
	CONCERN	Cracks between 0.25 in. and 0.5 in. and length less than 1 ft with no evidence of sediment entering	
	PASS	Crack less than 0.25 in. and less than 1 ft long with no evidence of sediment entering	
Ladder	FAIL	Missing rungs, rust, cracks, sharp edges	Visual inspection of rungs above sediment or water level. If ladder is covered with sediment or water, flag catch basin for inspection during cleaning.
	PASS	No missing rungs, rust, cracks, sharp edges	
Grate/cover	FAIL	Unable to open, missing, and/or broken	Visual inspection of grate and cover.
	PASS	Able to open, present, and intact	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen or by smell of contaminants such as petroleum products or organic compounds (e.g., paint thinner or acetone) within the catch basin including on top of water or sediment, or along the interior wall.
	PASS	Oil/gas/other pollution absent	
Inlet/outlet	FAIL	Greater than 33% blocked	Visual inspection to estimate percent blocked or use graduated rod measure blockage and inlet diameter to calculate percent blocked.
	PASS	Less than 33% blocked	
Trash and debris	FAIL	Blocking inlet, or greater than 60% sump depth	Visual inspection to determine blockage.
	PASS	Not blocking inlet, and less than 60% sump depth	
Cannot locate	FAIL	Cannot locate	Visual inspection for locating relative to map/GIS representation and identifier.
	PASS	Can locate	

Table 4-5. Catch Basin Cityworks Inspection Form with Inspection General Work Method

Criterion	Result	Explanation	General Work Method
Other	FAIL	Other, comment	Other can be used for any condition that is deemed unacceptable and is not covered by the other observation categories.
	PASS	None	
Lateral connection	Lateral	Indicates unmapped lateral is present and the origin appears to be from private property	Lateral is used to identify unmapped lateral connections. This criterion is important for IDDE screenings.
	Unknown	Indicates unmapped lateral is present but the origin is not known	
	Other	Other can be used for any connection that is not covered by the other observation categories	
	N/A	Did not find unmapped laterals.	
Maintenance recommendation	Repair	Recommend repair	Inspector indicates maintenance recommendation in field. Information used for generating work orders after field investigations and inspections.
	Replace	Recommend replacement	
	N/A	No recommendation for repair or replacement	
Priority	Yes	Repair or replacement have priority	Inspector indicates priority recommendation in field. Information used for generating work orders after field investigations and inspections.
	No	Repair or replacement are not a priority	

4.2.3 Catch Basin Maintenance and Construction BMPs

Table 4-6 summarizes maintenance for catch basins.

Table 4-6. Catch Basin Maintenance Summary

Element	Description
Maintenance interval	Catch basins and inlets must be inspected or cleaned every 2 years.
Maintenance type	<ul style="list-style-type: none"> Routine maintenance includes grout work and removing built-up materials and sediment with a vector truck. After the cleaning, inspect each basin on a case-by-case basis for structural repair. Non-routine maintenance includes lid replacement. Most hand-built brick basins no longer meet current design specifications. It is good practice to fully replace brick basins that are failing structurally. Failing cast catch basins may be able to be partially repaired.
Maintenance timing	<ul style="list-style-type: none"> Perform cleaning in dry months to avoid washing sediment-laden water downstream, optimize sediment removal, and minimize possible water quality impacts. For work done during wet periods or flowing water, the work is done with a vector truck with vectoring occurring downstream of pipe work to control the escape of sediment-laden water.
Reactive maintenance	<ul style="list-style-type: none"> Maintenance items such as damage from storms, car accidents, or construction may require special repairs or cleanup. Removal and replacement is the preferred method for failing hand-built basins. Ensure minimum of 2 bolts are securing the covers.
Permit requirements	<ul style="list-style-type: none"> NPDES: Cleaning, repair, or replacement of catch basins and inlets every 2 years. If a catch basin or inlet does not meet a maintenance standard, repairs must be made within 6 months. HPA: If work is being done within a piped stream, then work is done in accordance with the HPA requirements.
Exceptions and outliers	Catch basins and inlets with no sump cannot be cleaned as there is no buildup to remove. There are some smaller than standard catch basins that are City responsibility and must be cleaned by hand.

Table 4-7 lists general work methods for catch basin cleaning by vacuum.

Table 4-7. Catch Basin Cleaning by Vacuum General Work Method	
Activity Component	Activity Details and Description
Desired result	Catch basins are free of debris by vacuuming
Resources	<ul style="list-style-type: none"> • Crew: <ul style="list-style-type: none"> • 2-person crew • 2 flaggers (as needed) • Material: Water • Equipment: <ul style="list-style-type: none"> • 1 vacuum truck • 1 grate puller/T-bar • 1 backup truck with overhead arrow for traffic control • PPE (gloves, hardhat, safety glasses, rain gear, rubber boots, hearing protection) • Laptop, charger, and cleaning sheets • Contractor/vendor costs: • Debris: decant spoils • City-approved decant location
General work method	<ol style="list-style-type: none"> 1. Place traffic control signs and safety devices as required at job site 2. Use proper PPE 3. Apply all confined-space equipment 4. Crew persons 1 and 2 work together to remove catch basin lid and position equipment 5. Inspect for illicit discharge or connection (SMC 13.10.320); if illicit discharge observed initiate a water quality service request for IDDE investigation 6. Clean all surfaces, walls, brick, concrete, inlets and outfalls 7. Inspect condition of inlet, outfall, and brick/concrete structure 8. Clean inlets and outfalls if accumulated sediment is 20% or more of the pipe 9. Remove vacuum tube and replace lid or close hatch to avoid noise from traffic driving over it 10. Clean up job site, tools, and truck 11. Remove traffic control signs and safety devices as required at job site 12. Make notes about any further work that is needed 13. Decant vacuum truck in decant spoils bay 14. Accurately report in Cityworks

Table 4-8 lists general work methods for catch basin cleaning by hand.

Table 4-8. Catch Basin Cleaning by Hand General Work Method	
Activity Component	Activity Details and Description
Desired result	Manually remove leaves, debris, etc. from the inlets and outlets of culverts and pipes to improve drainage
Resources	<ul style="list-style-type: none"> • Crew: 2-person crew • Material: None • Equipment: <ul style="list-style-type: none"> • 1 service truck • 2 flat shovels • 1 broom • 1 grate puller • PPE (gloves, hardhat, safety glasses, rain gear, rubber boots, hearing protection) • Laptop, charger, and cleaning sheets • Contractor/vendor costs: • Debris: decant spoils • City-approved decant location
General work method	<ol style="list-style-type: none"> 1. Place traffic control signs and safety devices as required at job site 2. Remove grate and inspect to determine if repairs are needed and can be done on site 3. Inspect for illicit discharge or connection (SMC 13.10.320); if illicit discharge observed, initiate a water quality service request for IDDE investigation 4. Clean inlets and outfalls if accumulated sediment is 20% or more of the pipe 5. Use shovel and broom to remove leaves and debris in and around catch basin grate and gutter line 6. Collect debris and place in service truck 7. If work is required, use proper PPE 8. Clean up job site, tools, and truck 9. Remove traffic control signs and safety devices as required at job site 10. Make notes about any further work that is needed 11. Accurately report in Cityworks

Regional Road Guidelines BMPs for catch basin construction including installation, repair, and replacement are provided in Table 4-9 (Tri-County Working Group 2000).

Table 4-9. Catch Basin Construction Regional Road Guidelines BMPs	
Name	BMP Number
Excelsior-filled log	2.63
Inlet protection	2.79
Sandbag	2.109
Straw bale barrier (for dam and protection, not filtration)	2.127-2.135
Straw log	2.138
Vactoring	2.166

4.3 Constructed Wetland

Constructed wetlands in Shoreline, such as the wetland mitigation areas in Cromwell Park, are engineered wetland areas to detain stormwater runoff.

Related SOPs include gauge, natural channel, outfall, and pipe. Figure 4-3 shows an example of a constructed wetland in Shoreline.



Figure 4-3. Constructed wetland

4.3.1 Constructed Wetland Inspection

Constructed wetland inspection is initiated through Cityworks preventive work orders for regional facility that contains a constructed wetland. Table 4-10 is a representation of the CMMS inspection checklist in Cityworks for constructed wetland.

Table 4-10. Constructed Wetland Cityworks Form with Inspection General Work Method

Criterion	Result	Explanation	General Work Method
Sediment (Pretreatment)	FAIL	Sediment in pretreatment pool or sediment storage area exceeds design volume by 60% or more	Determine sediment depth by consulting design plans and gathering relative elevations
	PASS	Sediment is less than 60% of design volume in pretreatment pool or sediment storage area.	
	N/A	Feature not present	
Sediment (Main Cell)	FAIL	Sediment in the main cell has exceeded design volume by 50% or more.	Determine sediment depth by gathering relative elevation data and consulting design plans.
	PASS	Sediment is less than 50% of design volume in the main cell.	
Trash and Debris	FAIL	Trash and debris accumulated in pretreatment or permanent pool	Visual inspection of debris and trash accumulation.
	PASS	No accumulation of trash or debris	
Erosion/Stability	FAIL	Erosion, animal burrows or sinkholes on side slopes or embankment	Visual inspection side slopes and embankment
	PASS	No erosion, burrow or sink holes	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen on pretreatment or permanent pool, side slopes, embankments or by smell such as petroleum products or organic compounds (e.g., engine oil, paint thinner or acetone). Visual inspection of discolored or soapy water.
	PASS	Oil/gas/other pollution absent	
Vegetation (Embankment)	FAIL	Invasive plants are present or trees/woody vegetation on embankment, or vegetation coverage on 50% of original surface area has been lost	Visual inspection of plant and tree growth. See Section 5.9 Vegetation Control.
	PASS	No invasive plants, trees on embankment or excessive vegetation loss.	
Vegetation (Pond)	FAIL	Invasive plants are present or a 50% reduction in original open water surface area.	Visual inspection of plant and tree growth. See Section 5.9 Vegetation Control.
	PASS	Invasive plants are absent and no 50% reduction in original open water surface area.	
Inlets/Outlets	FAIL	Inlets or outlet are blocked with trash, debris or vegetation. Erosion occurring to supporting soil	Visual inspection of inlets and outlets for blockage or erosion.
	PASS	Inlets/outlets are not blocked and surrounding area is not eroding	
Algae Bloom	FAIL	Algae bloom is present	Inspect constructed wetland in fall and spring or other times when algal blooms are common.
	PASS	Algae bloom is absent	
Pond Level	FAIL	Pool level is much higher or lower than typically observed	Dramatic changes in pool level indicate a problem with clogging, embankment leakage or leaking riser or pipe. Familiarity with typical pool levels is achieved through frequent observation and recording pool level measurements
	PASS	Pool level is typical	

4.3.2 Constructed Wetland Maintenance

Table 4-11 summarizes maintenance for constructed wetlands.

Table 4-11. Constructed Wetland Maintenance Summary	
Element	Description
Maintenance interval	Constructed wetlands are inspected annually.
Maintenance type	<ul style="list-style-type: none"> • Routine maintenance includes cleaning and removing debris, harvesting vegetation, repairing embankment and side slopes, and repairing control structure. • Maintenance every 5 to 20 years includes removing accumulated sediment from permanent pool, pretreatment pool, or sediment storage area.
Maintenance timing	<ul style="list-style-type: none"> • Perform cleaning in dry months to avoid washing sediment-laden water downstream, optimize sediment removal, and minimize possible water quality impacts. • For work done during wet periods or flowing water, the work is done with a vactor truck with vactoring occurring downstream of pipe work to control the escape of sediment-laden water.
Reactive maintenance	Corrective maintenance is related to pool level changes such as removing clogging outlet, repairing gate valve, repairing leaks in pipes, liners, and embankments.
Permit requirements	HPA: If work is being done within a piped stream, then work is done in accordance with the HPA requirements.

4.4 Control Structure

A control structure is a device contained within another asset (e.g., manhole, catch basin, or vault) that restricts flow for flow control or helps maintain water quality by solids settlement or oil/water separation.

Related SOPs include catch basin, manhole, and vault. Figure 4-4 shows a typical control structure.



Figure 4-4. Control structure

4.4.1 Control Structure Inspection

Control structure inspection and repair are typically initiated through Cityworks preventive work orders for a surface water facility that contains the control structure.

Table 4-12 is a summary of the Cityworks custom inspection observation form for control structures. The form is a simplification of Table V-4.5.2(4) Maintenance Standards – Control Structure/Flow Restrictor”, Section 4.6, Volume V of 2014 SWMMWW, included in Appendix B.

Table 4-12. Control Structure Cityworks Form and Inspection General Work Method

Criterion	Result	Explanation	General Work Method
Sediment	FAIL	Greater than 25% of sump, or less than 1 ft below orifice plate	Use graduated rod or tape measure to measure sediment depth below orifice plate, and to estimate sediment depth and total depth from invert to sump bottom. Estimate percent depth of sediment. The sediment criterion for control structures overrides that of other structures such as catch basins or manholes.
	PASS	Less than 25% of sump, and greater than 1 ft below orifice plate	
Cleanout gate	FAIL	Damaged/missing	Visual inspection of the condition and intact nature of the cleanout gate.
	PASS	Intact/present	
Chain/handle	FAIL	Damaged/missing/inoperable	Visual inspection of the chain and handle of the control structure gate.
	PASS	Intact/present/operable	
Control structure intact	FAIL	Not intact	Visual inspection and use graduated rod, hand, or shovel to check control structure is intact with itself and its support structure.
	PASS	Intact	
Trash and debris	FAIL	Blocking outlet	Visual inspection to determine blockage from trash and debris.
	PASS	Not blocking outlet	
Other	FAIL	Other, comment	"Other, comment" means any condition that requires attention to remain or be returned to operation.
	PASS	None	

4.4.2 Control Structure Maintenance

Control structures are inspected and maintained on a varied basis depending upon the other surface water assets they are located within. The maintenance interval varies based on associate assets. Table 4-13 summarizes maintenance for control structures.

Table 4-13. Control Structure Maintenance Summary

Element	Description
Maintenance timing	Maintenance timing is based on the timing requirements of other surface water assets that control structures are contained within.
Maintenance type	<ul style="list-style-type: none"> Routine maintenance requires sediment removal from sump areas associated with the control structure. Structure components such as the clean out gate and gate chain/handle are operated during inspection and routine maintenance to ensure working condition. Corrective maintenance includes replacing or repairing broken or non-operational gate and chain/handle.
Reactive maintenance	Maintenance efforts to address conditions such as damage from storms, car accidents, pollutant spills or construction may require special repairs or clean up.

4.5 Culvert

A culvert is a pipe structure that conveys water under a road, trail, or similar obstruction from one side to the other. Driveway culverts are considered pipes and are inspected with the Pipe SOP.

Related SOPs include natural channel, pipe, pipe inlet structure, pond, and region facility. Figure 4-5 shows a typical culvert.



Figure 4-5. Culvert

4.5.1 Culvert Inspection

Culvert inspection is initiated through Cityworks preventative work orders under the regional inspection program. Large culverts under major roadways should also receive a specialized bridge inspection from bridge culvert trained technicians or engineers.

Table 4-14 provides details regarding the culvert Cityworks form and inspection general work method.

Table 4-14. Culvert Cityworks Form and Inspection General Work Method

Criterion	Result	Explanation	General Work Method
Sediment	FAIL	Greater than 20% of cross-sectional diameter	Use graduated rod or measuring tape to measure sediment depth and culvert diameter to calculate the percent of sediment of cross-sectional diameter at culvert inlet and outlet (if accessible). Estimate percent cross-sectional diameter.
	PASS	Less than 20% of cross-sectional diameter	
Vegetation	FAIL	Blocking free movement of water	Visual inspection of vegetation density.
	PASS	Not blocking free movement of water	
Dent	FAIL	Greater than 20% reduction in cross-section area	Visual inspection and estimation of dent cross-section area, relative to culvert cross-section area.
	PASS	Less than 20% reduction in cross-section area	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen or by smell of contaminants such as petroleum products or organic compounds (e.g., paint thinner or acetone) within the culvert included above the current water level. Visual inspection of discolored or soapy water.
	PASS	Oil/gas/other pollution absent	
Trash and debris	FAIL	Blocking inlet or outlet	Visual inspection of trash or debris blocking inlet and outlet.
	PASS	Not blocking inlet or outlet	
Headwall	FAIL	Damaged	Visual inspection of headwall for significant cracking, buckling, bulging, or displaced headwall, or erosion behind or around ends of headwall.
	PASS	Intact	
Other	FAIL	Other, comment	"Other, comment" means any condition that requires attention to remain or be returned to operation.
	PASS	None	

4.5.2 Culvert Maintenance

Culverts should be cleaned when blockage by sediment, debris or other natural material exceeds 20 percent of the culvert cross-sectional area. Trash (non-natural materials) should be removed whenever encountered. Culvert inlet and outlet should be free of any vegetation blocking culvert flows, including volunteer trees. Maintenance activities for stream-bearing culverts must be coordinated with Washington Department of Fish and Wildlife HPA permitting (and any applicable "fish window").

Reactive maintenance (repairs) needed for headwall failures and any other issues which may compromise structural integrity of the culvert, and possibly for repeated excessive sedimentation issues.

Table 4-15 summarizes maintenance for culverts.

Table 4-15. Culvert Maintenance Summary	
Element	Description
Maintenance interval	<ul style="list-style-type: none"> • Culvert inlet, outlet, and headwalls must be visually inspected every 2 years. • Large box culvert (such as the NE 196th St McAleer Creek culvert) interiors shall be visually inspected every 5 years by a qualified professional. • Culverts which exhibit visible signs of structural issues at inlet or outlet and/or sinking or settling of the surface above shall be scheduled immediately for emergency CCTV inspection. • High-priority pipe culvert interiors must be CCTV inspected every 5 years. High priority culverts meet three or more of the following criteria: <ul style="list-style-type: none"> • Conveys stream flow • 24 inches or greater in diameter • Crosses an arterial • Older than 40 years (or age unknown) • Other culverts can be CCTV inspected at regular stormwater pipe CCTV inspection intervals (20 years)
Maintenance type	<ul style="list-style-type: none"> • Routine maintenance includes removing vegetation, debris, and sediment. After the cleaning, re-inspect culvert structural condition. • Non-routine maintenance may include repair or replacement of defective trash racks and grouting or other minor headwall repairs.
Maintenance timing	<ul style="list-style-type: none"> • For work done within stream-bearing culverts, timing of work shall be per HPA permit. • Perform cleaning in dry months to avoid washing sediment-laden water downstream, optimize sediment removal, and minimize possible water quality impacts.
Reactive maintenance	Maintenance items such as damage from storms, car accidents, or construction may require special repairs or cleanup.
Permit requirements	HPA: If work is being done within a piped stream, then all work shall be done in accordance with the HPA requirements.

4.6 Dam

Dams within the city were primarily installed for flow control. When water is impounded, sediment and gross materials settle out. Dams help to lessen downstream erosion and water quality degradation. Dams do not generally impound low to moderate flows and may not improve flow control or water quality at these flows.

Related SOPs include control structure and gate valve. Figure 4-6 shows a dam within the city.



Figure 4-6. Dam

4.6.1 Dam Inspection

Dams within the city are also regional facilities subject to annual inspection. In addition, any major storms require a subsequent site visit and inspection of the dam. Table 4-16 is a representation of the CMMS inspection checklist in Cityworks for dams.

High hazard dams are inspected by the Department of Ecology (DOE) every 5 years. These inspections are conducted to identify deficiencies, and to reasonably assure safe operation and verify maintenance is adequately being performed. DOE provides a comprehensive report of the dam inspection directing any work needed to remediate deficiencies. Additionally, the City reports the results of its annual high hazard dam inspections to the DOE.

Table 4-16. Dam Cityworks Inspection Form

Criterion	Result	Explanation
Dam names	<ul style="list-style-type: none"> Boeing Creek M1 Dam Boeing Creek North Pond McAler Creek R/D Pond Pan Terra Pump Station Hidden Lake Outfall Firelane Ballinger Creek 	User selects dam name for inspection form
Owner name	<ul style="list-style-type: none"> City of Shoreline Other 	User selects owner
Address	<ul style="list-style-type: none"> 17500 Midvale Avenue N, Shoreline, WA 98133-4905 Other 	User selects owner address
Telephone number	<ul style="list-style-type: none"> 206.801.2700 Other 	User selects owner phone number
Weather	Describe weather at the time of inspection	User types comment
Reservoir level at time of inspection	Drained or estimate the elevation below dam crest	User types comment
Reservoir outflow at time of inspection	Estimate water depth in inches exiting in pipe	User types comment
Crest	<ul style="list-style-type: none"> Cracks in the crushing surface Depressions in the surface Evidence of burrowing animals All pass 	User selects any or all options and can add comment
Upstream face	<ul style="list-style-type: none"> Evidence of slope movement such as surface cracking and depressions Animal runs All pass 	User selects any or all options and can add comment
Downstream face	<ul style="list-style-type: none"> Wet soft areas Seepage All pass 	User selects any or all options and can add comment
Emergency spillway, low-level inlet pipe	<ul style="list-style-type: none"> N/A Crack in of the headwall Debris obscuring the trash rack Slide gate is properly lubricated, and the gate can be operated All pass 	User selects any or all options and can add comment
Emergency spillway drop inlet	<ul style="list-style-type: none"> N/A Debris accumulation on the grates of the trash rack Loose or missing bolts securing grate to concentric ring Seepage at the joints of through cracks in the concrete rings of the riser Vandals have plugged the air vent pipe or thrown debris into the riser structure All pass 	User selects any or all options and can add comment
Principal spillway inlet pipe	Fail	Debris accumulating on grating
	Pass	No debris accumulating on grating
Principal spillway control structure	Fail	Improper lubrication and position of canal grate
	Pass	Proper lubrication and position of canal grate

Table 4-16. Dam Cityworks Inspection Form

Criterion	Result	Explanation
Principal spillway catch basin	N/A	A principal spillway catch basin was not incorporated into the design
	Fail	Catch basin piping is obstructed
	Pass	Catch basin piping is not obstructed
Principal spillway plunge pool	Erosion damage the impedes proper drainage	User selects any or all options and can add comment
	Vegetation growth that impedes proper drainage	
	All pass	
	N/A	
Contra Costa stilling basin (outlet structure)	Fail	Cracking at the head wall
	N/A	
	Pass	No cracking at the head wall

High hazard dams are inspected by Ecology every 5 years. These inspections are conducted to identify deficiencies, and to reasonably assure safe operation and verify maintenance is adequately being performed. Ecology provides a comprehensive report of the dam inspection directing any work needed to remediate deficiencies.

Additionally, the City reports the results of its annual high hazard dam inspections to the Ecology.

4.6.2 Dam Maintenance

Table 4-17 summarizes maintenance for dams.

Table 4-17. Dam Maintenance Summary

Element	Description
Maintenance type	The primary maintenance of dams is vegetation control and sediment removal. The dam area must remain clear of trees and shrubs. Pipes, inlets, and other structures will require sediment removal periodically.
Maintenance timing	<ul style="list-style-type: none"> Maintenance work on dams is primarily done during dry months. All dams within the city have streams flowing through them, and have components with HPA-related restrictions. Sediment removal should be done in July or August with no flowing water, and no rain expected during the work window. If necessary, erosion control materials should be used above the ordinary high water mark where soils are exposed. Clearing of grates, inlets, and outfalls may occur year-round. Emergency work in proximity to a stream requires an emergency HPA, and other maintenance should refer the EAP (explained below).
Reactive maintenance	Slope failure (including water seepage) is evidence that the dam may require significant repair. The pipe structures may need restoration or repair such as replacing rusted sections of large CMP or grouting within catch basins or manholes. The Ecology Office of Dam Safety conducts an inspection every 5 years. This inspection and subsequent report may instruct maintenance items for the City to complete.
Permit requirements	<ul style="list-style-type: none"> The Ecology Office of Dam Safety requires that the City maintain an EAP related to the high-hazard dams. The EAP is required and must be updated as needed. Updates include reconstruction of the dam, change or ownership, and significant land use changes downstream. All the dams within the city contain streams, and in-water work requires abiding by the maintenance HPA. Facilities must be inspected annually and after a 10-year rain event. When an inspection identifies an exceedance of the maintenance standard, maintenance shall be performed within 1 year for typical maintenance and within 2 years for maintenance that requires capital construction of less than \$25,000. Catch basins within regional facilities must have maintenance conducted within 6 months.
Exceptions and outliers	There are 2 high-hazard dams within the city (North Pond and M1). These facilities are complex with different assets and needs. Each site should be treated as independent assets and have management adapted to site conditions. M1 has minimal public access while North Pond is surrounded by Boeing Creek Park.

4.7 Ditch

Ditches act primarily as conveyance assets. Some ditches may provide some level of flow control, water quality treatment, or infiltration. The vegetation within a ditch slows water and traps suspended sediment. As water flows through a ditch line it also infiltrates into the surrounding soil.

Related SOPs include pipe inlet structure and pipe. Figure 4-7 shows a typical ditch.



Figure 4-7. Ditch

4.7.1 Ditch Inspection

The City completed a full circuit of City-owned ditches from 2008–13. Since 2014, approximately one-third of the City ditches are inspected each year. Figure 4-8 shows the ditch maintenance zones. See Appendix D for a more detailed ditch and maintenance procedure.

Table 4-18 is a representation of the CMMS inspection checklist in Cityworks for ditches.

Table 4-18. Ditch Cityworks Inspection Form with Inspection General Work Method

Criterion	Result	Explanation	General Work Method
Sediment	FAIL	Greater than 33% of design depth	Visual inspection of the slope of the ditch channel bottom. Using inlet and outlet pipe inverts as references look for a low or high spots that are approximately 1/3 higher or lower the rest of the ditch.
	PASS	Less than 33% of design depth	
Vegetation	FAIL	Blocking free movement of water	Visual inspection of vegetation density.
	PASS	Not blocking free movement of water	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen on vegetation or soil or by smell of contaminants such as petroleum products or organic compounds (e.g., paint thinner or acetone).
	PASS	Oil/gas/other pollution absent	
Trash and debris	FAIL	Present	Visual inspection of presence of trash or debris.
	PASS	Absent	
Inlet/outlet	FAIL	Greater than 33% blocked	Visual inspection to estimate percent blocked or use graduated rod measure blockage and inlet diameter to calculate percent blocked.
	PASS	Less than 33% blocked	
Sediment	FAIL	Does not meet design specifications	Visual inspection of sediment deposits.
	PASS	Meets design specifications	
Flow spreader	FAIL	Flows are not evenly distributed	Visual inspection of shoulder to allow roadway drainage sheet flow evenly to ditch.
	PASS	Flows are evenly distributed	
Vegetation condition	Residential maintained	The ditch appears to be maintained by adjacent property owner	Visual observation of ditch vegetation condition. Ditch appears to be mown or otherwise maintained by owner. Estimate vegetation height and use judgement for safety (line of sight for vehicles) or functional issues.
	Not maintained	The ditch does not have vegetation requiring maintenance	
	Vegetation substantial	The ditch is overgrown, but this does not represent a safety or a functional issue; vegetation 24 in. or higher	
	Vegetation minimal	The ditch does not appear to be resident maintained, but the vegetation is minimal; vegetation shorter than 24 in.	
Lateral Connection	Lateral	Indicates unmapped lateral is present and origin is from private property	Lateral is used to identify unmapped lateral connections. The criterion is important for IDDE screenings.
	Unknown	Indicates unmapped lateral is present but the origin is not known	
	Other	Other can be used for any connection that is not covered by the other observation categories	
	N/A	Did not find any unmapped laterals	
Weir	FAIL	Not intact	Check pass or fail if ditch has weir (most ditches do not have a weir). If the weir would not cause water to pond behind it and slow water down, it is considered not intact.
	PASS	Intact	
Erosion	FAIL	Bank or channel erosion present	Visual inspection of channelization (localized deepening of channel at center) or bank erosion.
	PASS	Bank or channel erosion absent	
Cannot locate	FAIL	Cannot locate	Visual inspection for locating relative to map/GIS representation and identifier.
	PASS	Can locate	
Other	FAIL	Other, comment	"Other, comment" means any condition that requires attention to remain or be returned to operation.
	PASS	None	

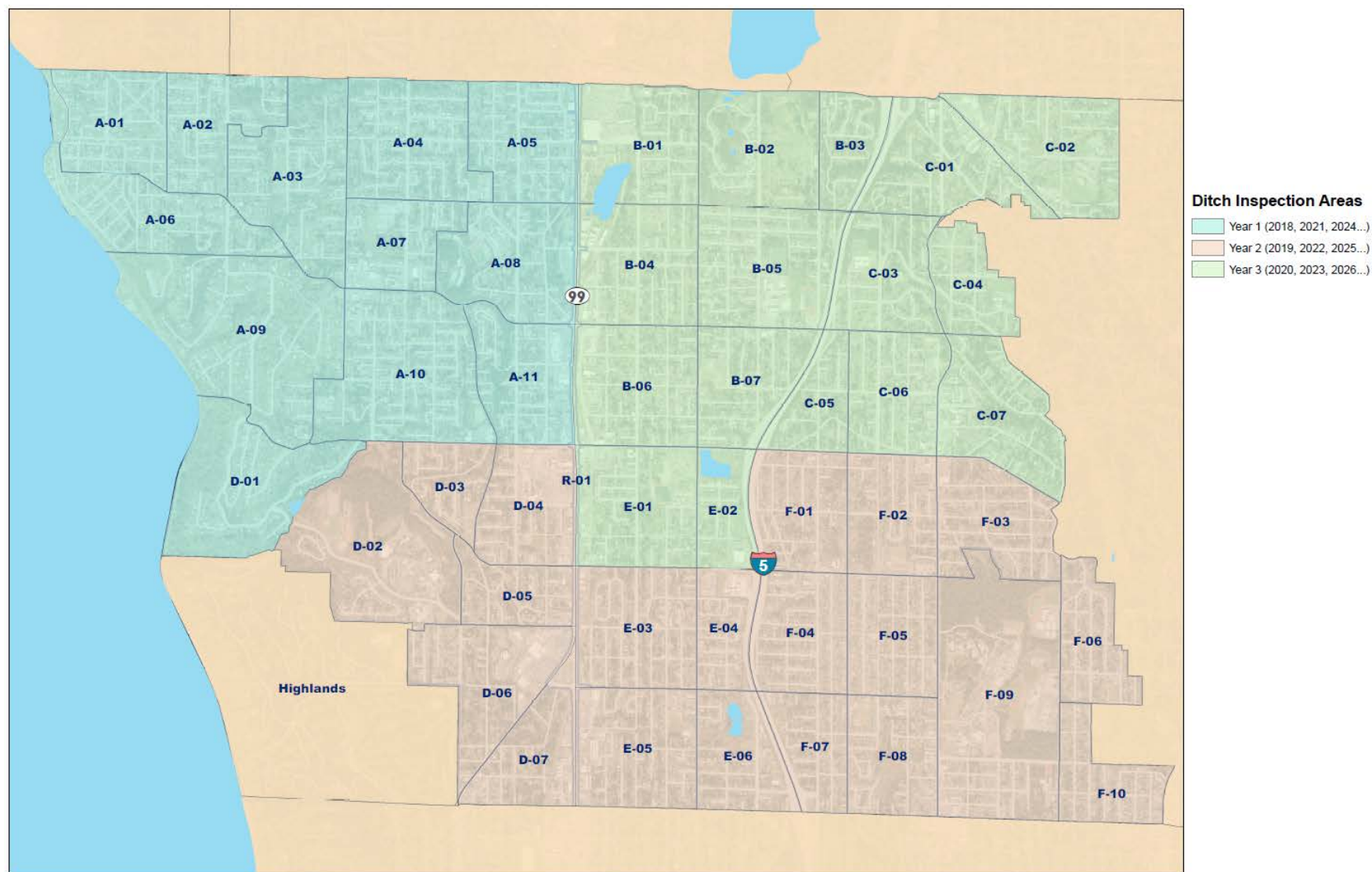


Figure 4-8. Ditch maintenance zones

4.7.2 Ditch Maintenance and Construction BMPs

Table 4-19 summarizes ditch maintenance.

Table 4-19. Ditch Maintenance Summary	
Element	Description
Maintenance timing	Ditch maintenance is done primarily during dry months to avoid washing turbid water downstream. Routine work is scheduled for the driest periods to optimize sediment removal and minimize possible water quality impacts. Emergency work may be done during wet periods but erosion control must be employed to prevent erosion.
Maintenance type	Of the 1/3 of ditches inspected annually, only ditches out of specification (e.g., sediment is built up to the point of restricting flow) are cleaned using a truck-mounted auger. Where ditches cannot be cleaned by auger, the ditch may be reshaped by hand, backhoe, or hydro-excavation. Vegetation control occurs only if it will inhibit the auger operation. The inlet and outlet of the ditch are also inspected and associated culverts are cleaned as necessary.
Reactive maintenance	Ditches may be cleared out of sequence because of excessive sediment buildup. Restoration may be required if a ditch slope fails. Material may need to be removed from a ditch where shoulder materials have been pushed into them as part of a road project. Shoulder work is done to reshape and clean roadside to reconnect the shoulder flow spreader to ditch.
Permit requirements	Permit regulations related to ditches focus primarily on the inlet and outlet. However, when an inspection identifies an exceedance of the maintenance standard, maintenance shall be performed within 1 year for typical maintenance and within 2 years for maintenance that requires capital construction of less than \$25,000. In addition, there may be HPA requirements if the ditch is classified as a stream.
Exceptions and outliers	<ul style="list-style-type: none"> Ditches are only maintained when flow or function are impaired. General mowing and vegetation maintenance are not part of the maintenance envelope and do not impede the function of the ditch. Ditches that carry perennial flows may be classified as a stream and must be treated as such.

Most ditches are maintained with an auger. Ditches with access limitations may require a backhoe to perform the necessary maintenance. Smaller ditches may be maintained with a small amount of hand digging. Table 4-20 describes ditch maintenance using an auger.

Table 4-20. Ditch Maintenance with Auger General Work Method

Activity Component	Activity Details and Description
Desired result	Remove sediment, leaves, and debris with auger machine to improve flow. Clear inlet and outfall pipes, if needed.
Resources	<ul style="list-style-type: none"> • Crew: <ul style="list-style-type: none"> • 2-person crew • 2 flaggers, if needed • Material: <ul style="list-style-type: none"> • Quarry rock • Coir logs with stakes • Equipment: <ul style="list-style-type: none"> • 1 auger mounted truck with dump body • PPE (gloves, hardhat, safety glasses, rain gear, rubber boots, hearing protection) • Contractor/vendor costs: • Debris: ditching • City-approved disposal method
General work method	<ol style="list-style-type: none"> 1. Place traffic control signs and safety devices as required at job site 2. Use proper PPE 3. Notify front desk who will email police, fire, and public works if access to road will be impacted 4. Inspect for illicit discharge or connection (SMC 13.10.320); if illicit discharge observed, initiate a water quality service request for IDDE investigation 5. Remove accumulated sediment in ditch that exceeds 20% of designed ditch depth 6. Remove debris from ditch to provide adequate flow 7. Quarry rock outfalls and around outlet pipe from ditch as needed 8. Install coir logs with stakes as needed 9. Clean up job site, tools, and truck 10. Remove traffic control signs and safety devices as required at job site 11. Notify front desk who will email police, fire, and public works that access to road has been returned 12. Accurately report in Cityworks

Table 4-21 describes ditch maintenance using a back hoe.

Table 4-21. Ditch Maintenance with Back Hoe General Work Method	
Activity Component	Activity Details and Description
Desired result	Remove sediment, leaves, and debris with backhoe or excavator to improve flow. Clear inlet and outfall pipes, if needed.
Resources	<ul style="list-style-type: none"> • Crew: <ul style="list-style-type: none"> • 2-person crew • 2 flaggers, if needed • Material: <ul style="list-style-type: none"> • Quarry rock • coir logs with stakes • Equipment: <ul style="list-style-type: none"> • 1 dump truck • 1 equipment trailer • 1 service truck • 1 excavator or backhoe with ditching bucket • PPE (gloves, hardhat, safety glasses, rain gear, rubber boots, hearing protection) • Contractor/vendor costs: • Debris: ditching • City-approved disposal Method
General work method	<ol style="list-style-type: none"> 1. Place traffic control signs and safety devices as required at job site 2. Use proper PPE 3. Notify front desk who will email police, fire, and public works if access to road will be impacted 4. Inspect for illicit discharge or connection (SMC 13.10.320); if illicit discharge observed, initiate a water quality service request for IDDE investigation 5. Remove accumulated sediment in ditch that exceeds 20% of designed ditch depth 6. Remove noxious vegetation that may constitute a hazard to City personnel or public according to applicable regulations 7. Clean inlets and outfalls if accumulated sediment is 20% or more of the pipe; if pipe needs rodding, initiate a rodding request 8. Remove debris from ditch to provide adequate flow 9. Straw or seed as needed 10. Quarry rock outfalls and around outlet pipe from ditch as needed 11. Install coir logs with stakes as needed 12. Clean up job site, tools, and truck 13. Remove traffic control signs and safety devices as required at job site 14. Notify front desk who will email police, fire, and public works that access to road has been returned 15. Accurately report in Cityworks

Table 4-22 describes ditch maintenance by hand.

Table 4-22. Ditch Maintenance by Hand General Work Method	
Activity Component	Activity Details and Description
Desired result	Remove sediment, leaves, and debris manually to improve flow. Clear inlet and outfall pipes, if needed.
Resources	<ul style="list-style-type: none"> • Crew: 2-person crew • Material: <ul style="list-style-type: none"> • Quarry rock • coir logs with stakes • Equipment: <ul style="list-style-type: none"> • 1 service truck • PPE (gloves, hardhat, safety glasses, rain gear, rubber boots, hearing protection) • 2 shovels • Contractor/vendor costs: • Debris: ditching • City-approved disposal method
General work method	<ol style="list-style-type: none"> 1. Place traffic control signs and safety devices as required at job site; use proper PPE 2. Notify front desk who will email police, fire, and public works if access to road will be impacted 3. Inspect for illicit discharge or connection (SMC 13.10.320); if illicit discharge observed, initiate a water quality service request for IDDE investigation 4. Remove accumulated sediment in ditch that exceeds 20% of designed ditch depth 5. Remove noxious vegetation that may constitute a hazard to City personnel or public according to applicable regulations 6. Clean inlets and outfalls if accumulated sediment is 20% or more of the pipe 7. Remove sediment and debris from ditch to provide adequate flow 8. Straw or seed as needed 9. Quarry rock outfalls and around outlet pipe from ditch as needed 10. Install waddles with stakes as needed 11. Clean up job site, tools, and truck 12. Remove traffic control signs and safety devices as required at job site 13. Notify front desk who will email police, fire, and public works that access to road has been returned 14. Accurately report in Cityworks

Regional Road Guidelines BMPs for ditch construction including installation, repair, and replacement are included in Table 4-23 (Tri-County Working Group 2000).

Table 4-23. Ditch Construction Regional Road Guidelines BMPs	
Name	BMP Number
Cofferdam	2.26
Coir log	2.31
Dewatering	2.50
Ditch lining	2.54
Excelsior-filled log	2.63
Grass-lined channel	2.67
Hand seeding	2.75
Hydro seeding	2.77
Inlet protection	2.79
Rip rap	2.103
Rock check dam	2.105
Sandbag	2.109
Silt fence	2.114
Soil stabilization (blankets and matting)	2.122
Straw bale barrier	2.127-2.135
Straw log	2.138
Stream bypass	2.142
Triangular silt dike	2.162
Vegetative buffer	2.168

4.8 Drain

Drain assets are either trench, French, or underdrains, and are a component of other assets (e.g., bioretention facility, Filterra™ unit).

SOPs associated with drains include bioretention facility, stormwater facility, and Filterra.

4.8.1 Drain Inspection

Drain inspection and repair are typically initiated through Cityworks preventive work orders for surface water assets that contain or are connected to a drain. Table 4-24 is a representation of the CMMS inspection checklist in Cityworks for drains.

Table 4-24. Drain Cityworks Inspection Form with Inspection General Work Method			
Criterion	Result	Explanation	General Work Method
Sediment	FAIL	Greater than 33% of pipe diameter	Where accessible for viewing, visually inspect drain and estimate amount of sediment within pipe.
	PASS	Less than 33% of pipe diameter	
Vegetation	FAIL	Blocking free movement of water	Visual inspection of vegetation blocking inlet or outlet.
	PASS	Not blocking free movement of water	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen or by smell of contaminants such as petroleum products or organic compounds (e.g., paint thinner or acetone).
	PASS	Oil/gas/other pollution absent	
Trash and debris	FAIL	Blocking Inlet/outlet	Visual inspection to determine blockage.
	PASS	Not blocking Inlet/outlet	
Cannot locate	FAIL	Cannot locate	Visual inspection for locating relative to map/GIS representation and identifier.
	PASS	Can locate	
Other	FAIL	Other, comment	"Other, comment" means any condition that requires attention to remain or be returned to operation.
	PASS	None	

4.8.2 Drain Maintenance

Drain maintenance is typically a corrective maintenance and is due to sediment accumulation or flow obstruction caused by vegetation growth or trash and debris.

Table 4-25 summarizes the maintenance for drains.

Table 4-25 Drain Maintenance Summary	
Element	Description
Maintenance timing	Maintenance timing is based on the requirements of other surface water assets that drains are a component of.
Maintenance type	Corrective maintenance requires sediment, vegetation or debris removal that obstructs drain flow.
Reactive maintenance	Maintenance efforts to address conditions such as damage from storms, car accidents, pollutant spills or construction may require special repairs or clean up.

4.9 Filters

Stormwater filters, housed in either vaults or catch basin structures contain media in either cartridges or bags. The media filters the runoff, removing pollutants prior to entering the downstream stormwater system. The City has two such types of filter systems: The Aqua-Filter System by AquaShield which comprises of an Aqua-Swirl chamber combined with Aqua-Filter bagged media and the CONTECH StormFilters which are comprised of media-fill cartridges.

Refer to Table 4-26 for type, location, and number of filters for each structure

Table 4-26. Filter System Information		
Type	Address	No. Cartridges/Bags
CONTECH StormFilter	16053 Aurora Ave N	114
	16503 Aurora Ave N	25
	1201 N 175st	6
	17500 Midvale Ave N	6
	15235 Aurora Ave N	51
AquaFilter by AquShield	15801 Aurora Ave N	1

Related SOPs include catch basin, manhole and vault. Figure 4-9 shows illustrations of the two types of filters.

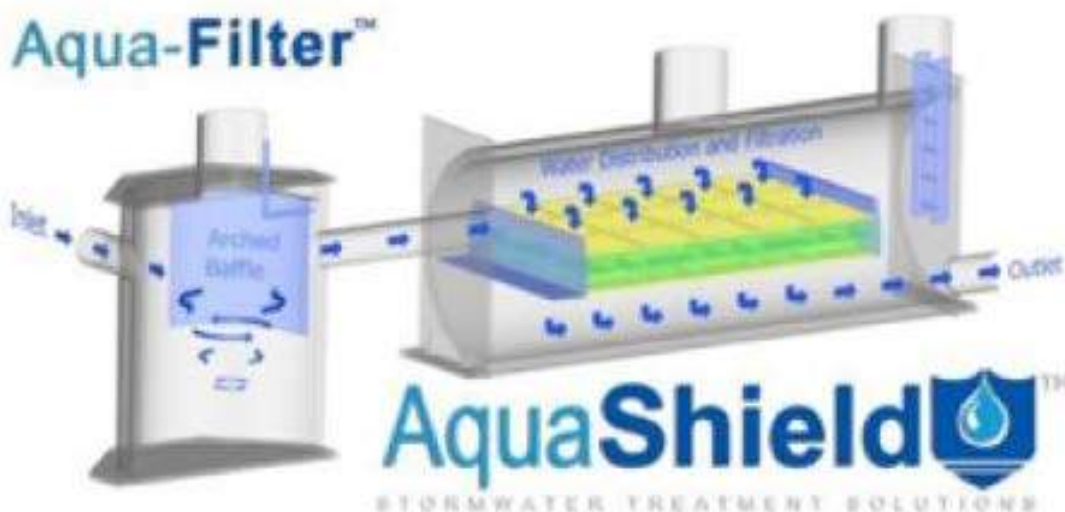
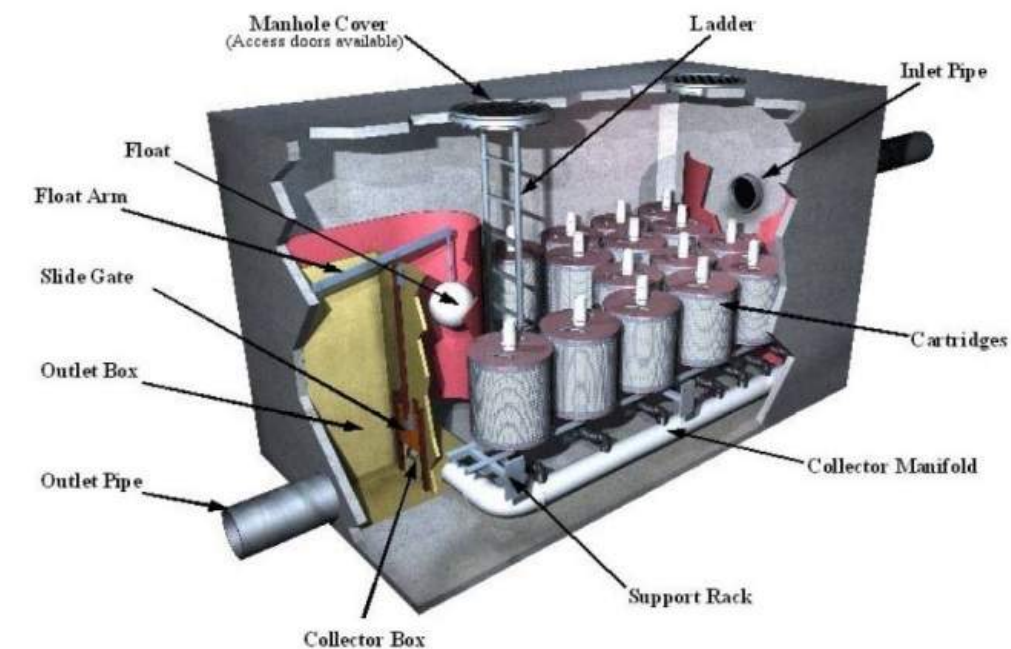


Figure 4-9. Filters

Top: StormFilter, bottom: Aqua-Filter™.

4.9.1 Filter Inspection

Filters and the structures that contain them (i.e., vaults and catch basins) are inspected at least once a year during Facility or Regional stormwater inspection, depending on their location. As a part of a proprietary system with a separate facility-based O&M manual, filters may be inspected more frequently.

Although filters do not have a separate inspection form in Cityworks, a failed inspection is recorded in the “Other” criterion for the structure asset and replacement work order is submitted for the filters. Table 4-27 is a representation of the inspection criterion from the CONTECH StormFilters operations and maintenance manual.

Table 4-27. CONTECH StormFilter with Inspection General Work Method

Criterion	Result	Explanation	General Work Method	Frequency
Sediment	FAIL	Greater than 4 in. in Vault or greater than 1/4 in. on top of cartridge	Visual inspection of thickest sediment deposits within structure.	Annually
	PASS	Less than 4 in. in Vault or Less than 1/4" on top of cartridge		
Submerged Cartridges	FAIL	Greater than 4 in. of static water in cartridge bay for more than 24 in. after end of rain event	Visual inspect structure for static water near 24 hours after rain event. Rain event should be greater than 1 in. in 12-hour period.	Annually after major rain event producing greater than 1 in. of rain within 12 hour period
	PASS	Less than 4 in. of static water in cartridge bay for more than 24 in. after end of rain event		
Bypass Condition	FAIL	Constant state of bypass with cartridges submerged	Visual Inspect structure during average rainfall event of 0.05 in. per hour	Annually during average rainfall event
	PASS	Bypass is not being utilized and cartridges are not submerged		
Scum Line	FAIL	Greater than 1/4 in. is present above top cap	Visual inspect scum line in chamber	Annually
	PASS	Scum line below top cap		
Calendar Lifecycle	FAIL	Greater than 3 years since maintenance	Verify last maintenance on Stormfilters	Annually
	PASS	Less than 3 years since maintenance		

The Aqua-Filter system has two components to inspect and maintain. The first being the Aqua-Swirl chamber, a type of hydrodynamic separator and the Aqua-Filter media vault. Table 4-28 list the inspection criteria for the Aqua-Filter Media taken from the Aqua-Filter O&M manual (see Appendix E). The inspection and maintenance of the Aqua-Swirl chamber are covered in Section 4.14 Hydrodynamic Separator and Appendix E. Ecology maintenance standards for manufactured media filters are included in Appendix B, Table V-4.5.2(15) "Maintenance Standards – Manufactured Maintenance Standards", Section 4.6, Volume V of 2014 SWMMWW.

Table 4-28. Aqua-Filter Media Inspection General Work Method

Criterion	Result	Explanation	General Work Method	Frequency
Sediment	FAIL	Greater than 1/4 in. on top of filter media bags	Use pole or rod to determine distance from sediment to surface of water in chamber	Annually
	PASS	Less than 1/4 in. on top of filter media bags		
Media	FAIL	Media is dark brown or black	Visually inspect media in bags for color	Annually
	PASS	Media is whitish color		

Appendices E and F to this manual, for the AquaShield Aqua-Filter System and the CONTECH StormFilter, respectively, are the inspection and maintenance procedures from the manufacturer's O&M Manuals for these systems.

4.9.2 Filter Maintenance

Table 4-29 summarizes filter maintenance.

Table 4-29. Filter Maintenance Summary	
Element	Description
Maintenance timing	Filter maintenance should be done during dry months from June to September.
Maintenance type	Maintenance includes removing sediment from the vault by vactor and replacing media cartridges or bags. Confined space is necessary to replace media in vaults or Type 2 catch basins.
Reactive maintenance	Maintenance should be conducted when a large illicit spill is observed which could impact the performance of the filters immediately.
Permit requirements	Permit regulations related to stormwater BMPs focus primarily on performance. Where an inspection identifies an exceedance of the maintenance standard, maintenance shall be performed within 1 year for typical maintenance and within 2 years for maintenance that requires capital construction of less than \$25,000.

Refer to the respective O&M manuals for guidelines on the work method for replacing and maintaining filters, Appendix E for AquaSheild Aqua-Filter System and Appendix F for CONTECH StormFilter.

4.10 Filterra™

Filterra facilities are like other biofiltration facilities but are generally smaller and offer more tightly set water quality features.

Biofiltration acts as water quality and flow control. These facilities impound water in a shallow depression, and as water infiltrates it encounters soil media and plant roots, which improve the general parameters of water quality. The designed infiltration rate acts as flow control. The soil media for Filterra facilities appears to release less phosphate than other bioinfiltration facilities, leading to different BMPs relating to water release.

Related SOPs include catch basin, drain, and pipe. Figure 4-10 shows a Filterra biofilter installation.



Figure 4-10. Filterra

4.10.1 Filterra Inspection

Filterra units should be inspected on a bi-annual basis, with routine maintenance occurring annually. In addition to the maintenance of units, the inlets to the Filterra should be cleared on a routine basis occurring quarterly as a minimum. Table 4-30 is a representation of the CMMS inspection checklist in Cityworks for Filterra.

Table 4-30. Filterra Cityworks Inspection Form with Inspection General Work Method

Criterion	Result	Explanation	General Work Method
Sediment	FAIL	Present in curb cut or planter area	Visual inspection of sediment in planter area.
	PASS	Absent in curb cut or planter area	
Vegetation	FAIL	Weeds present	Visual inspection.
	PASS	Weeds absent	
Plant health	FAIL	Unhealthy, dying	Visual inspection of plant health.
	PASS	Healthy	
Trash and debris	FAIL	Present	Visual inspection of trash or debris in Filterra unit.
	PASS	Absent	
Mulch	FAIL	Thin coverage	Visual inspection of mulch depth less than 2 in.
	PASS	Adequate coverage	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen on mulch or plant, or by smell of contaminants such as petroleum products or organic compounds (e.g., paint thinner or acetone).
	PASS	Oil/gas/other pollution absent	
Under drain	FAIL	Blocked or plugged	Visual inspection of underdrain or signs of ponding from blocked underdrain.
	PASS	Clear	
Curb Cut	FAIL	Opening restricted	Visual inspection of curb cut opening.
	PASS	Opening not restricted	
Other	FAIL	Other, comment	"Other, comment" means any condition that requires attention to remain or be returned to operation.
	PASS	None	

4.10.2 Filterra Maintenance

Table 4-31 summarizes Filterra maintenance. See Appendix G for Filterra maintenance steps from the Filterra manufacturer O&M Manual.

Table 4-31. Filterra Maintenance Summary

Element	Description
Maintenance timing	Maintenance is broken down into growing season and dormant season (non-growing). During the growing season (March–September), general upkeep is conducted along with any other reactive maintenance. During the dormant season (October–February), maintenance includes sediment removal at inlets and clearing of debris from outfalls.
Maintenance type	During the annual inspection: place dissipater stones to the side, replace mulch, remove trash, clear the inlet, and evaluate the plant and media per the Filterra O&M manual.
Reactive maintenance	If the plant/tree is failing to thrive or dies, it should be replaced. Filter media should be replaced if infiltration rates appear too slow or fast. Replace energy dissipater stones as needed.
Permit requirements	Facilities must be inspected annually and after a 10-year rain event. When an inspection identifies an exceedance of the maintenance standard, maintenance shall be performed within 1 year for typical maintenance and within 2 years for maintenance that requires capital construction of less than \$25,000. Catch basins within regional facilities must have maintenance conducted within 6 months.

4.11 Floodwall

Floodwalls are walls constructed at a design elevation and water pressure capacity to keep floodwaters on the downstream or flood side of the wall. Current recorded floodwall assets are contained within a regional facility delineation. SOPs associated with Floodwalls include Ronald Bog.

4.11.1 Floodwall Inspection

Floodwalls should be inspected annually as part of a Regional Stormwater Inspection. Table 4-32 is a representation of the CMMS inspection checklist in Cityworks for floodwalls.

Table 4-32. Floodwall Cityworks Inspection Form with Inspection General Work Method			
Criterion	Result	Explanation	General Work Method
Structure	FAIL	Wall exhibits visible structural damage	Visual inspection along entire extent of wall on both sides
	PASS	Wall exhibits no visible structural damage	
Settlement	FAIL	Wall has settled 4 in. lower than design elevation	Survey elevation of top of wall and compare to design elevation.
	PASS	Wall is within 4 in. of design elevation	
Sinkhole/Burrow	FAIL	Present on either side of wall	Visual inspection along entire extent of wall on both sides.
	PASS	Absent on either side of wall	
Erosion	FAIL	Present on either side of wall	Visual inspection along entire extent of wall on both sides.
	PASS	Absent on either side of wall	
Seepage	FAIL	Present on either side of wall	Visual inspection along entire extent of wall on both sides.
	PASS	Absent on either side of wall	
Vegetation	FAIL	Overgrown, restricting access, or noxious weeds present	Visual inspection along entire extent of wall on both sides.
	PASS	Not overgrown, unrestricted access, and noxious weeds absent	

4.11.2 Floodwall Maintenance

The primary maintenance of floodwalls is vegetation control and sediment removal. The floodwall area must remain clear of trees and shrubs. Table 4-33 summarizes maintenance for floodwalls.

Table 4-33. Floodwall Maintenance Summary	
Element	Description
Maintenance interval	Floodwalls are inspected annually as part of the regional facility inspection for Ronald Bog.
Maintenance type	Routine maintenance for floodwalls is vegetation control and sediment removal. Vegetation control may include the removal of trees and shrubs.
Reactive maintenance	Reactive maintenance would address conditions such as settlement greater than 4 in.; sinkholes, burrows, erosion or seepage on either side of the wall; or structural damage.
Permit requirements	

4.12 Gate Valve

Gate valves are a component of other assets that detain surface water such as ponds and vaults. Gate valve operation helps control flows.

Related SOPs include control structure. Figure 4-11 shows an example of a gate valve.



Figure 4-11. Gate valve

4.12.1 Gate Valve Inspection

Gate valve inspection and repair are typically initiated through Cityworks preventive work orders for a surface water facility that contains a gate valve. Table 4-34 is a representation of the CMMS inspection checklist in Cityworks for gate valves.

Table 4-34. Gate Valve Cityworks Inspection Form with Inspection General Work Method			
Criterion	Result	Explanation	General Work Method
Wheel	FAIL	Seized, broken, or bent	Visual inspection wheel element
	PASS	Not seized, broken or bent	
Frame	FAIL	Broken or bent	Visual inspection of frame
	PASS	Not broken or bent	
Shaft	FAIL	Broken or bent	Visual inspection of shaft
	PASS	Not broken or bent	

4.12.2 Gate Valve Maintenance

Table 4-35 summarizes the maintenance for gate valves.

Gate valves can be located in confined space. Follow necessary safety and personal protection guidelines when inspecting, cleaning and maintaining gate valve.

Table 4-35. Gate Valve Maintenance Summary	
Element	Description
Maintenance interval	Maintenance timing is based on the timing requirements of other surface water assets that gate valves are contained within or associated with.
Maintenance type	Gate valves should be exercised and greased at least annually to ensure moving parts are clean and operating smoothly. Valve exercise should follow manufacturer's recommendations and typically includes checking that seats are clean and provide a tight seal.
Reactive maintenance	Reactive gate valve maintenance includes repairing or replacing equipment (wheel, frame or shaft) that is broken, bent, or seized.

4.13 Gauge

Gauges are a component of other assets that measure water flow or level in surface water assets that hold or convey water. Gauges can be connected to recording devices or simply measure information to be read during inspections.

Related SOPs include natural channel, and pond and Ronald Bog. Figure 4-12 shows a stream gauge.



Figure 4-12. Stream gauge

4.13.1 Gauge Inspection

Gauge inspection and repair are typically initiated through Cityworks preventive work orders for a surface water facility that contains a gauge. Table 4-36 is a representation of the CMMS inspection checklist in Cityworks for gauge.

Table 4-36. Gauge Cityworks Inspection Form with Inspection General Work Method			
Criterion	Result	Explanation	General Work Method
Access	FAIL	Access is blocked or difficult	Visual inspection of access.
	PASS	Accessible	
Intact	FAIL	Broken or bent, detached	Visual inspection that gauge and housing is intact and attached to intended connection
	PASS	Not broken or bent or detached	
Operational	FAIL	Not recording or measuring	Visual inspection of operation and reading
	PASS	Recording or measuring	
Verified Results	FAIL	Recorded information not verified or does not calibrate	Where applicable compare gauge reading with reported or recorded values on separate device or system.
	PASS	Recorded information is verified or calibrated	

4.13.2 Gauge Maintenance

Table 4-37 summarizes gauge maintenance

Table 4-37. Gauge Maintenance Summary	
Element	Description
Maintenance interval	Maintenance timing is based on the timing requirements of other surface water assets that gauges are contained within or associated with.
Maintenance type/timing	Preventative maintenance for gauges includes clearing debris, sediment or vegetation of gauge access to ensure operation and readability. Gauges should be verified and recalibrated, if necessary.
Reactive maintenance	Reactive maintenance may include repairing broken, bent or detached gauge housing and connection.

4.14 Hydrodynamic Separator

Hydrodynamic separators are stormwater features that provide stormwater treatment in areas where high urban pollution stormwater runoff may be present. The separators function to capture trash, sediment, debris, and hydrocarbons from runoff, often placed as pretreatment to filters, bioretention, and other Low Impact Development water quality treatment.

The City has three proprietary types of hydrodynamic separators throughout the City used as primary treatment or pretreatment. Table 4-38 shows the manufacturer, model, location, function of each type of separator and reference to the appendix in this Manual of the manufacturer's O&M manual.

Table 4-38. Hydrodynamic Separators				
Manufacturer	Model	Address	Function	Appendix
AquaShield	AquaSwirl	15720 Aurora Ave N	Pretreatment	Appendix E
CONTECH	CDS System	17840 5 th Ave NE	Pretreatment	Appendix F
Hydro International	First Defense	1125 N 152 nd St	Primary	Appendix I

4.14.1 Hydrodynamic Separator Inspection

Separators are housed in catch basin-like structures and are inspected as such during the regional facility inspections. Table 4-39 shows the inspection criteria for separators.

Table 4-39. Separator Inspection General Work Method				
Criterion	Result	Explanation	General Work Method	Frequency
Sediment	FAIL	Greater than 48 in. from surface of the water to sediment in chamber	Use pole or rod to determine distance from sediment to surface of water in chamber	Annually
	PASS	Less than 42 in. from surface of the water to sediment in chamber		
Trash Debris	FAIL	Debris or trash visible in chamber	Visually inspect for trash and debris.	Annually
	PASS	No debris or trash observed		
Oil	FAIL	Greater than 0.5 in. of oil layer present	Visual inspect and measure using rod or pole	Annually
	PASS	Less than 0.5 in. of oil layer present		

If catch basins with separators fail one or more of the criteria in Table 4-39, a 'Vector Sediment' work order for the vault or catch basin is created to clean the structure and the separator. See Section 2, O&M Work Flow Process.

4.14.2 Hydrodynamic Separator Maintenance

Table 4-40 summarizes the maintenance for hydrodynamic separators.

Table 4-40. Hydrodynamic Separator Maintenance Summary

Element	Description
Maintenance interval	Maintenance timing is based on the timing requirements of other surface water assets that hydrodynamic separators are contained within or associated with (vault or catch basin).
Maintenance type/timing	Maintenance for hydrodynamic separators are conducted when a failure is indicated during the inspection. Maintenance consists of washing down the separator and cleaning out the structure which it is performed by vactor.
Reactive maintenance	Maintenance efforts to address conditions such as damage from storms, car accidents, pollutant spills or construction may require special repairs or clean up.

4.15 Infiltration Pipe

An infiltration pipe is a perforated pipe that allows water to infiltrate directly into the surrounding soil. Infiltration pipes are located in stormwater facilities and roadway shoulders.

SOPs associated with infiltration pipes include control structure and catch basin.

4.15.1 Infiltration Pipe Inspection

The infiltration pipes located within City operated facilities are visually inspected during facility inspections. The roadside infiltration pipes are inspected during the City's basin planning programs. Infiltration pipes are on a 20-year pipe condition assessment schedule.

4.15.2 Infiltration Pipe Maintenance

Infiltration pipe cleaning and repair help maintain infiltration rates and mitigate localized flooding. CCTV inspection is recommended for infiltration pipes whenever cleaning is ineffective in restoring function.

Table 4-41 summarizes the maintenance for infiltration pipe.

Table 4-41. Infiltration Pipe Maintenance Summary	
Element	Description
Maintenance timing	Roadside infiltration pipes are on a two-year maintenance schedule initiated through a Cityworks preventative pipe jet work order.
Maintenance type	Routine maintenance includes removing sediment from pipe jet cleaning. CCTV inspection is recommended for infiltration pipes whenever cleaning is ineffective in restoring function.
Reactive maintenance	Maintenance efforts to address conditions such as damage from storms, car accidents, pollutant spills or construction may require special repairs or clean up.

4.16 Manhole

Manholes primarily serve as junctions for storm or sanitary sewer systems when a change in horizontal or vertical alignment must occur. Manholes can also serve as access points to the pipe system for maintenance purposes. Manholes differ from catch basins in that the overall maximum depth may be greater and there is no sump provided below the outlet pipe invert.

SOPs associated with manholes include control structure and pipe. Figure 4-13 shows a typical manhole cover.



Figure 4-13. Manhole

4.16.1 Manhole Inspection

Type 1 and 2 manholes are generally inspected as part of a facility inspection, or are maintained reactively. Table 4-42 is a representation of the CMMS inspection checklist in Cityworks for manholes. The form is a simplification of the maintenance standards for “Table No. 5–Catch Basins” from Section 4.6, Volume V of 2014 SWMMWW (Ecology 2014). Manhole inspection may require confined space entry. Follow necessary safety and personal protection guidelines when inspecting, cleaning and maintaining manholes.

Table 4-42. Manhole Cityworks Inspection Form with Inspection General Work Method

Criterion	Result	Explanation	General Work Method
Sediment	FAIL	Greater than 60% at lowest invert	Use graduated rod to estimate sediment depth and total depth from invert to sump bottom. Estimate percent depth of sediment. If this criterion fails, create a vactor sediment work order.
	PASS	Less than 60% at lowest invert	
Frame/slab	FAIL	Holes larger than 2.00 in. ² or cracks larger than 10.25 in.	Visual inspection of the frame and slab and use hole size guidelines to determine FAIL, CONCERN or PASS. If the structure has issues but does not require immediate repair, select CONCERN.
	CONCERN	Holes between 1.00 and 2.00 in. or cracks greater than 0.125 in. and less than 0.250 in.	
	PASS	No holes larger than 1.00 in. ² and cracks less than 0.125 in.	
Walls/bottom	FAIL	Judgment that structure is unsound and needs immediate repair or replacement; function of basin is severely compromised	Visual inspection of walls and bottom concrete, missing bricks or large cracks. If bottom is covered with sediment, flag manhole for inspection during cleaning.
	CONCERN	Judgement that there are structural issues but basin is functioning; may need minor repair	
	PASS	No structural issues; function of basin is sound	
Grout fillet (pipe to wall)	FAIL	Crack greater than 0.5 in. and longer than 1 ft with evidence of sediment entering	Visual inspection of the connection of pipes to manhole wall. Visually estimate width and length or cracks with graduated rod or tape measure.
	CONCERN	Cracks between 0.25 in. and 0.5 in. and length less than 1 ft with no evidence of sediment entering	
	PASS	Crack less than 0.25 in. and less than 1 ft long with no evidence of sediment entering	
Ladder	FAIL	Missing rungs, rust, cracks, sharp edges	Visual inspection of rungs above sediment or water level. If ladder is covered with sediment or water, flag manhole for inspection during cleaning.
	PASS	No missing rungs, rust, cracks, sharp edges	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen or by smell of contaminates such as petroleum products or organic compounds (e.g., paint thinner or acetone) within the manhole including on top of water or sediment, or along the interior wall.
	PASS	Oil/gas/other pollution absent	
Inlet/outlet	FAIL	Greater than 33% blocked	Visual inspection to estimate percent blocked or use graduated rod measure blockage and inlet diameter to calculate percent blocked.
	PASS	Less than 33% blocked	
Trash and debris	FAIL	Blocking inlet, or greater than 60% sump depth	Visual inspection to determine blockage.
	PASS	Not blocking inlet, and less than 60% sump depth	
Cannot locate	FAIL	Cannot locate	Visual inspection for locating relative to map/GIS representation and identifier.
	PASS	Can locate	
Other	FAIL	Other, comment	“Other, comment” means any condition that requires attention to remain or be returned to operation.
	PASS	None	
Lateral connection	Lateral		Lateral is used to identify unmapped lateral connections. This criterion important for IDDE investigations.
	Unknown		
	Other		
	N/A		

4.16.2 Manhole Maintenance and Construction BMPs

Table 4-43 summarizes the maintenance for manholes.

Table 4-43. Manhole Maintenance Summary	
Element	Description
Maintenance type	<ul style="list-style-type: none"> • Routine maintenance includes removing built-up materials and sediment with a vactor truck. After the cleaning, inspect each basin on a case-by-case basis for structural repair. • Non-routine maintenance includes grouting and lid replacement. Most hand-built brick basins no longer meet current design specifications and should be replaced if significant repair is required, while cast basins may be able to be partially repaired.
Maintenance timing	<ul style="list-style-type: none"> • Perform cleaning in dry months to avoid washing of sediment-laden water downstream, optimize sediment removal and minimize possible water quality impacts. • For work done during wet periods or flowing water, the work is done with a vactor truck with vactoring occurring downstream of pipe work to control the escape of sediment-laden water.
Reactive maintenance	<ul style="list-style-type: none"> • Maintenance items such as damage from storms, car accidents, or construction may require special repairs or cleanup. Removal and replacement is the preferred method for failing hand-built basins. • Locking lids should be used if the lid is in the travel lane or any location on an arterial street.

Table 4-44 summarizes the general work method for cleaning manholes by vacuuming.

Table 4-44. Manhole Cleaning General Work Method	
Activity Component	Activity Details and Description
Desired result	manholes are cleaned and free of debris by vacuuming.
Resources	<ul style="list-style-type: none"> • Crew: <ul style="list-style-type: none"> • 2-person crew • 2 flaggers (as needed) • Material: <ul style="list-style-type: none"> • Water • Equipment: <ul style="list-style-type: none"> • 1 vactor truck • 1 J-Hook/Manhole Cover Puller • 1 backup truck with overhead arrow for traffic control (if needed) • PPE (gloves, hardhat, safety glasses, rain gear, rubber boots, hearing protection) • Laptop, charger, and cleaning sheets • Contractor/vendor costs: • Debris: decant spoils • City-approved decant location
General work method	<ol style="list-style-type: none"> 1. Place traffic control signs and safety devices as required at job site 2. Use proper PPE 3. Apply all confined space equipment 4. Senior maintenance and Utility person work together to position equipment, remove manhole lid, and insert rod to measure sediment level 5. Inspect for illicit discharge or connection (SMC 13.10.320); if illicit discharge observed, initiate a water quality service request for IDDE investigation 6. Vacuum debris from storm manhole; clean all surfaces, walls, brick, concrete, inlet and outfall 7. Inspect condition of inlet, outfall, and brick/concrete structure 8. Clean inlets and outfalls if accumulated sediment is 20% or more of the pipe 9. Replace and secure lid to avoid noise from traffic driving over it 10. Clean up job site, tools, and truck 11. Remove traffic control signs and safety devices as required at job site 12. Decant vactor truck in decant spoils bay 13. Make notes about any further work that is needed 14. Accurately report in Cityworks

Regional Road Guidelines BMPs for manhole construction including installation, repair, and replacement are included in Table 4-45 (Tri-County Working Group 2000).

Table 4-45. Manhole Construction Regional Road Guidelines BMPs	
Name	BMP Number
Excelsior-filled log	2.63
Inlet protection	2.79
Sandbag	2.109
Straw bale barrier	2.127-2.135
Straw log	2.138
Vactoring	2.166

4.17 Media Filter Drain

A media filter drain is a linear flow-through stormwater runoff treatment device that can be sited along highway side slopes (conventional design) and medians (dual-media filter drains), borrow ditches, or other linear depressions. Media filter drains provide water quality treatment through filtration and sediment deposition.

Related SOPs include control structure. Figure 4-14 shows the plan and profile for a media filter drain.

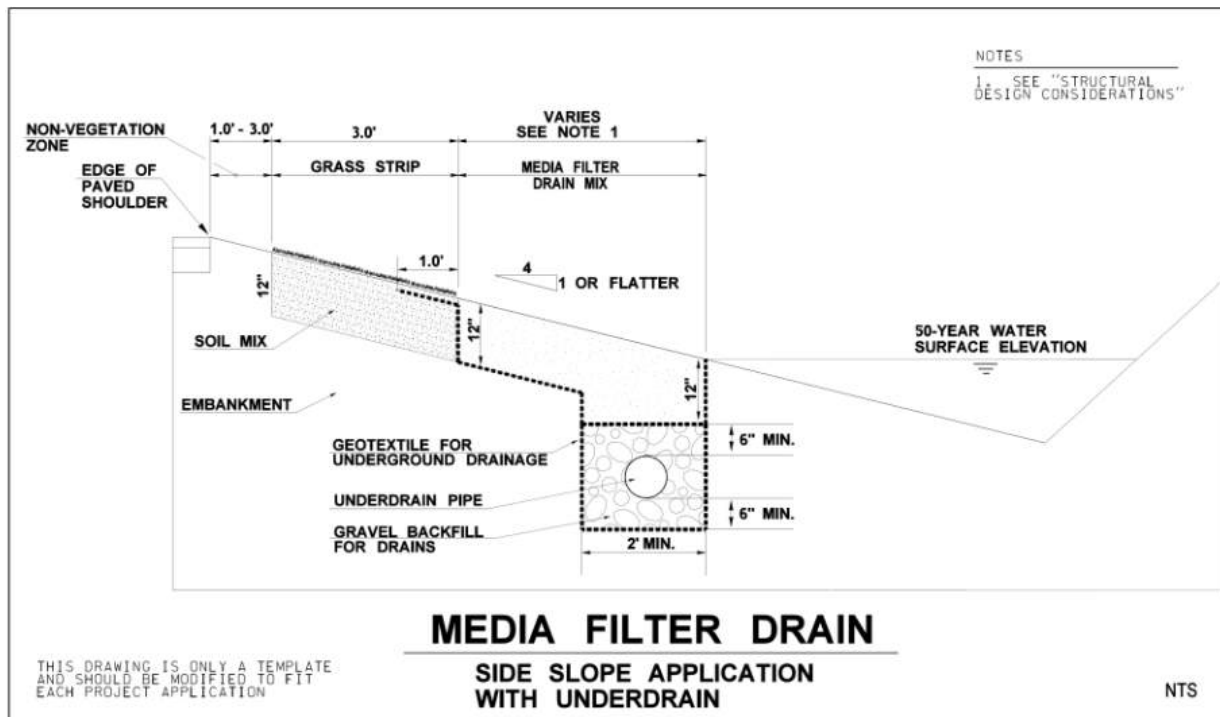


Figure 4-14. Media filter drain

4.17.1 Media Filter Drain Inspection

Media filter drains are inspected annually and typically in coordination with other assets associated with a stormwater facility. Table 4-46 is a representation of the CMMS inspection checklist in Cityworks for media filter drains. The form is a simplification of Table V-4.5.2(19) Maintenance Standards – Media Filter Drain (MFD)", Section 4.6, Volume V of 2014 SWMMWW, included in Appendix B.

Table 4-46. Media Filter Drain Cityworks Inspection Form with Inspection General Work Method

Criterion	Result	Explanation	General Work Method
Sediment	FAIL	Greater than 2 in. on grass	Visual inspection of sediment on grass.
	PASS	Less than 2 in. on grass	
Vegetation	FAIL	Grass greater than 10 in. high, poor vegetation coverage, or weeds present	Visual inspection of grass height.
	PASS	Grass less than 10 in. high, adequate vegetation coverage, and weeds absent	
Trash and debris	FAIL	Present	Visual inspection of trash or debris.
	PASS	Absent	
Excessive shading	FAIL	Overhanging limbs or brushy vegetation on slopes	Visual inspection of nearby vegetation.
	PASS	No overhanging limbs and no brushy vegetation on slopes	
Flow spreader	FAIL	Uneven	Visual inspection of sediment on grass.
	PASS	Even	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen on gravel or grass, darkened soil, or by smell of contaminants such as petroleum products or organic compounds (e.g., paint thinner or acetone).
	PASS	Oil/gas/other pollution absent	
Cannot locate	FAIL	Cannot locate	Visual inspection for locating relative to map/GIS representation and identifier.
	PASS	Can locate	
Curb cut	FAIL	Opening restricted	Visual inspection of curb cut openings.
	PASS	Opening not restricted	
Other	FAIL	Other, comment	"Other, comment" means any condition that requires attention to remain or be returned to operation.
	PASS	None	

4.17.2 Media Filter Drain Maintenance

Table 4-47 summarizes maintenance for media filter drains.

Table 4-47. Media Filter Drain Maintenance Summary

Element	Description
Maintenance timing	Media filter drains are maintained on an annual basis during the dry season (August).
Maintenance type	Maintenance will consist of routine roadside management. Excessive vegetation should be cleared from the no-vegetation zone (vegetation-free zone) as this area acts as level spreader to promote sheet flow and a deposition area for coarse sediments.
Reactive maintenance	<ul style="list-style-type: none"> Maintenance items such as damage from storms, car accidents, pollutant spills, or construction may require special repairs or cleanup. Do not allow vehicles or traffic on the media filter drain to minimize rutting and maintenance repairs.

4.18 Natural Channel

Natural channels have inherent value as natural systems, which offer habitat and can, when healthy, offer some water quality and storage functions. Natural channels are heavily protected by regulations, and are the primary beneficiaries of water quality and flow control provided outside of the natural channel itself.

Related SOPs associated with natural channels include ditch, culvert, outfall, and pipe inlet structure.



Figure 4-15. Natural channel

4.18.1 Natural Channel Inspection

Natural channels are not inspected or maintained on a regular interval. Portions of the natural channels that are located near or intersect a stormwater facility, such as a wetland or pond, are inspected as part of a regional stormwater facility inspection. Natural channels are managed through environmental assessments and regulatory processes, applied by various means (basin planning and both public and private projects, which are within critical area buffers).

Natural channels may be evaluated during basin studies or other types of analysis. During a study, flow and function are primary points of interest. The Utility may only have an interest related to a natural channel within public property, ROW, and private property with easements. Table 4-48 is a representation of the CMMS inspection checklist in Cityworks for natural channels.

Table 4-48. Natural Channel Cityworks Inspection Form with Inspection General Work Method

Criterion	Result	Explanation	General Work Method
Vegetation	FAIL	Blocking free movement of water	Visual inspection of vegetation density.
	PASS	Not blocking free movement of water	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen on water, channel bank or by smell such as petroleum products or organic compounds (e.g., paint thinner or acetone). Visual inspection of discolored, or soapy water.
	PASS	Oil/gas/other pollution absent	
Trash and debris	FAIL	Present	Visual inspection of presence of trash or debris.
	PASS	Absent	
Inlet/outlet	FAIL	Greater than 33% blocked	Visual inspection to estimate percent blocked or use graduated rod measure blockage and inlet diameter to calculate percent blocked.
	PASS	Less than 33% blocked	
Weir	FAIL	Not intact	Check pass or fail if ditch has weir (most ditches do not have a weir). If the weir would not cause water to pond behind it and slow water down, it is considered not intact.
	PASS	Intact	
Erosion	FAIL	Bank or excessive channel erosion present	Visual inspection excessive channel erosion or bank erosion.
	PASS	Bank or excessive channel erosion absent	
Cannot locate	FAIL	Cannot locate	Visual inspection for locating relative to map/GIS representation and identifier.
	PASS	Can locate	
Other	FAIL	Other, comment	"Other, comment" means any condition that requires attention to remain or be returned to operation.
	PASS	None	

4.18.2 Natural Channel Maintenance and Construction BMPs

Table 4-49 summarizes the maintenance for natural channels.

Table 4-49. Natural Channel Maintenance Summary

Element	Description
Maintenance timing	Natural channel maintenance is explicitly done during dry months unless permitted otherwise by a site-specific HPA. Routine work is scheduled within the work window specified by permit to minimize potential water quality impacts. Work done outside of the work window must be explicitly covered by permit or as part of an emergency response that also has authorization
Maintenance type	The primary maintenance related to natural channels is at the junction of other assets such as a culvert going under a street. At times sediment removal or erosion repair may be necessary depending on location or severity of impact to City infrastructure.
Reactive maintenance	Sediment removal and erosion repair are the most common but infrequent type of maintenance on natural channels. There may be work related to assets adjoining natural channels such as culverts that do not directly impact the channel, but precautions must be made to prevent the release of turbid water or debris.
Permit requirements	Natural channels may have multiple overlaying permit requirements. HPA permit restrictions may limit the time frame or scope of work to be done. Any significant work would require submissions for separate permits and is not covered under the City general HPA permit. Because of the complexity of permitting surrounding work on/over/around natural channels, it must be assumed that any work related to this asset requires permit coverage.
Exceptions and outliers	Many natural channels flow through private property with no easement. Changes to the channel are not always documented and impacts may be in place for long periods prior to failing or being reported. When a change is noted, it is important to reach out to the property owner and work with them to restore the channel as needed under current laws and regulations.

Regional Road Guidelines BMPs for natural channel construction including installation, repair, and replacement are included in Table 4-50 (Tri-County Working Group 2000).

Table 4-50. Natural Channel Construction Regional Road Guidelines BMPs	
Name	BMP Number
Coir log	2.26
Dewatering	2.31
Ditch lining	2.50
Diversion channel	2.54
Excelsior-filled log	2.58
Grass-lined channel	2.63
Hand seeding	2.67
Hydro seeding	2.75
Inlet protection	2.77
Large woody material	2.79
Live staking	2.88
Mulching	2.93
Rip rap	2.97
Rock check dam	2.103
Sandbag	2.105
Silt fence	2.109
Soil stabilization (blankets and matting)	2.114
Straw bale barrier	2.122
Straw log	2.127-2.135
Stream bypass	2.138
Streambed gravel	2.142
Triangular silt dike	2.146
Vegetative buffer	2.162

4.19 Oil/Water Separator

An oil/water separator is a device that is designed to remove oil, grease, and similar floatable pollutants from stormwater runoff.

Related SOPs include catch basin, manhole, and vault. Figure 4-16 shows a typical oil/water separator.



Figure 4-16. Oil/water separator

4.19.1 Oil/Water Separator Inspection

Oil/water inspection and repair are typically initiated through Cityworks preventive work orders for a surface water facility that contains the oil/water separator, or during a routine annual or biennial inspection.

Table 4-51 is a summary of the Cityworks custom inspection observation form for oil/water separator. The form is a simplification of Table V-4.5.2(16) “Maintenance Standards – Baffle Oil/Water Separators (API)” and Table V-4.5.2(17) “Maintenance Standards – Coalescing Plate Oil/Water Separators”, Section 4.6, Volume V of 2014 SWMMWW, included in Appendix B.

Table 4-51. Oil/Water Separator Cityworks Inspection Form with Inspection General Work Method			
Criterion	Result	Explanation	General Work Method
Sediment	FAIL	Greater than 6 in. depth in bottom of vault, or sediment on plates	Use a graduated rod to measure depth of sediment. Visual inspection of sediment on plates.
	PASS	Less than 6 in. depth in bottom of vault, and no sediment on plates	
Oil Accumulation	FAIL	Greater than 1 in. at water surface	Use a graduated rod to measure depth oil accumulation at water surface.
	PASS	Less than 1 in. at water surface	
Baffles	FAIL	Corroding, cracking, or warping	Visual inspection of baffles.
	PASS	No corrosion, cracking, or deformation	
Coalescing plates	FAIL	Plate media broken, deformed, or cracked	Visual inspection of plates.
	PASS	Plate media intact	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen on mulch or plant, or by smell of contaminants such as petroleum products or organic compounds (e.g., paint thinner or acetone).
	PASS	Oil/gas/other pollution absent	
Other, comment	Other, comment	Other, comment	“Other, comment” means any condition that requires attention to remain or be returned to operation.
PASS	None	None	

4.19.2 Oil/Water Separator Maintenance

Vaults and manholes that house oil/water separators should be cleaned of sediment, debris, and oil. The oil/water separator components such as baffles, vault structures, and access equipment should be cleaned and not broken or bent.

Refer to manufacturer’s O&M Manual for cleaning of coalescing plates and hazardous waste disposal. See Appendix J for VortClarex brand Oil/Water Separator inspection and maintenance guidelines. Liquid hazardous waste can be transported and disposed of at a King County Industrial Waste Facility. Spill kits and other spill response BMPs should be implemented during maintenance activities to prevent contamination.

Follow necessary safety and personal protection guidelines when inspecting, cleaning and maintaining oil/water separators.

Table 4-52 summarizes oil/water separator maintenance.

Table 4-52. Oil/Water Separator Maintenance Summary

Element	Description
Maintenance timing	Maintenance timing is based on the timing requirements of other surface water assets that oil water separators are contained within. Maintenance is done during dry months to avoid washing of oil or sediment-laden water downstream. If there is work done during wet periods, water must be routed around the structure containing the oil/water separator while the work is completed. If a significant rain event is predicted, the work must be postponed.
Maintenance type	Routine maintenance for oil/water separator includes cleaning baffles and coalescing plate media of accumulated oil or debris.
Reactive maintenance	Reactive maintenance includes replacing cracked or broken baffles or plate. Maintenance efforts to address conditions such as damage from storms, car accidents, pollutant spills or construction may require special repairs or clean up.

4.20 Outfall

An outfall is a downstream discharge point from any stormwater to any body of water (Puget Sound, pond, etc.) or ditch.

Related SOPs include control structure, culvert, ditch, natural channel, and pond. Figure 4-17 shows a typical outfall discharge.



Figure 4-17. Outfall

4.20.1 Outfall Inspection

Outfall inspection and repair are typically initiated through Cityworks preventive work orders for other stormwater assets that contain or upstream of an outfall. Table 4-53 is a summary of the Cityworks custom inspection observation form for outfalls.

Table 4-53. Outfall Cityworks Inspection Form with Inspection General Work Method			
Criterion	Result	Explanation	General Work Method
Outlet	FAIL	Greater than 33% blocked	Use graduated rod or measuring tape to measure sediment depth and outfall pipe diameter to estimate the percent of sediment of cross sectional diameter at pipe outlet.
	PASS	Less than 33% blocked	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen on water, channel bank or by smell such as petroleum products or organic compounds (e.g., paint thinner or acetone). Visual inspection of discolored or soapy water.
	PASS	Oil/gas/other pollution absent	
Trash and Debris	FAIL	Present	Visual inspection of trash and debris.
	PASS	Absent	
Cannot locate	FAIL	Cannot locate	Visual inspection for locating relative to map/GIS representation and identifier.
	PASS	Can locate	
Other	FAIL	Other, comment	"Other, comment" means any condition that requires attention to remain or be returned to operation.
	PASS	None	

4.20.2 Outfall Maintenance

Table 4-54 summarizes the maintenance for outfalls.

Table 4-54. Outfall Maintenance Summary	
Element	Description
Maintenance timing	Outfall maintenance is done during dry months to minimize potential water quality impacts. If the outfall discharges to a natural channel, work is done explicitly during dry months unless permitted otherwise by a site-specific HPA. Routine work is scheduled within the work window specified by permit to minimize potential water quality impacts. Work done outside of the work window must be explicitly covered by permit or as part of an emergency response that also has authorization
Maintenance type	Outfalls should be kept clean of vegetation, debris, and sediment. Many outfalls will need a rock pad to prevent erosion. Those outfalls with a rock pad will require maintenance of the rock (e.g., fresh rock replacement upon inspection). Outfalls without a rock pad and showing signs of erosion will also need one.
Reactive maintenance	Maintenance efforts to address conditions such as damage from storms, car accidents, pollutant spills or construction may require special repairs or clean up.
Permit requirements	Outfalls discharging to natural channels may be subject to multiple overlaying permit requirements. HPA permit restrictions may limit the time frame or scope of work to be done. Any significant work would require submissions for separate permits and is not covered under the City general HPA permit.
Exceptions and outliers	Some outfalls discharge to ditches or natural channels on private property with no easement. Changes to the outfall are not always documented and impacts may be in place for long periods prior to failing or being reported. When a change is noted, it is important to reach out to the property owner and work with them to restore the outfall as needed under current laws and regulations.

4.21 Permeable Pavement

Permeable pavements allow water to infiltrate through surfaces that would normally be impermeable. These pavements provide a smooth, stable surface for walking or driving, yet allow water to filter through them and into the soils or bedding material below. The most common two are pervious concrete and porous asphalt. The most common permeable pavements in Shoreline are sidewalks, park trails, and parking cut ins. Many permeable pavement installations in Shoreline are adjacent to bioinfiltration facilities and are a component of a surface water facility.

Figure 4-18 shows a typical example of permeable pavement sidewalk usage.

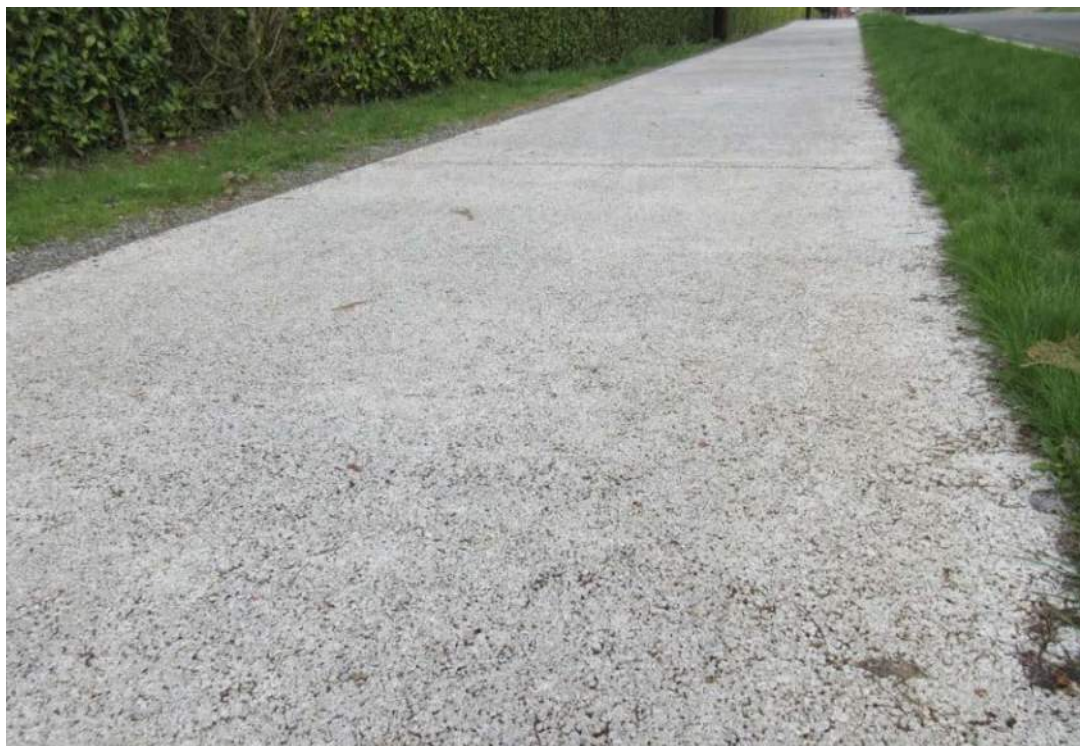


Figure 4-18. Permeable pavement

4.21.1 Permeable Pavement Inspection

Table 4-55 is a summary of the Cityworks custom inspection observation form for permeable pavements. The form is a simplification of Table V-4.5.2(22) “Maintenance Standards – Permeable Pavement”, Section 4.6, Volume V of 2014 SWMMWW, included in Appendix B. Based on results from the Cityworks visual inspection (such as sediment, gravel or moss in the pores of pavement or between pavers), follow-up infiltration tests according to the ASTM C1701/C1701M, see Appendix K, can be conducted to determine if the permeable pavement is functioning within the required range.

Table 4-55. Permeable Pavement Cityworks Inspection Form with Inspection General Work Method

Criterion	Result	Explanation	General Work Method
Sediment	FAIL	Sediment in pores of pavement or between pavers	Visual inspection of sediment on pavement.
	PASS	No sediment in pores of pavement or between pavers	
Trash and debris	FAIL	Present	Visual inspection of trash and debris.
	PASS	Absent	
Weeds/moss	FAIL	Present	Visual inspection of weeds or moss growing on the permeable pavement.
	PASS	Absent	
Gravel fill	FAIL	Missing or sparse	Visual inspection of extent of gravel fill.
	PASS	Present and adequate	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen or darkened surface on permeable pavement or by smell such as petroleum products or organic compounds (e.g., paint thinner or acetone).
	PASS	Oil/gas/other pollution absent	
Other	FAIL	Other, comment	"Other, comment" means any condition that requires attention to remain or be returned to operation.
	PASS	None	

4.21.2 Permeable Pavement Maintenance and Construction BMPs

Table 4-56 summarizes the maintenance for permeable.

Table 4-56. Permeable Pavement Maintenance Summary

Element	Description
Maintenance timing	Permeable pavements are maintained annually.
Maintenance type	Permeable pavement sidewalks are maintained by keeping them clean and free of soil, weeds, and other debris. Routine maintenance may include raking or sweeping once in the year in the fall, or as needed, to prevent clogging. Vacuuming and/or pressure washing is recommended once a year, or as needed, based on infiltration testing. Perform corrective maintenance within 1 year of inspection. Typical corrective maintenance includes vacuuming and/or pressure washing.
Reactive maintenance	Reactive maintenance includes removal of moss, ground cover, and washout from planted areas based on observed or tested clogging. Maintenance efforts to address conditions such as damage from storms, car accidents, pollutant spills, or construction may require special repairs or cleanup.
Permit requirements	NPDES: Inspection must occur annually. If a permeable pavement does not meet a maintenance standard, general repairs must be made in 1 year and capital repairs in 2 years.

Table 4-57 lists the general work method recommended for routine maintenance for permeable pavement in general and by specific type of permeable pavement.

Table 4-57. Permeable Pavement Routine Maintenance General Work Method

Maintenance Activity	Recommended Frequency	Notes
Observation ports	Visually check observation ports, if available at least twice annually.	<ul style="list-style-type: none"> Remove cap of observation port. Measure depth between observed water level and top of lid for port. Replace cap securely when done. Keep a record of measurements (including date) in maintenance log. Check project-specific O&M manual for minimum distance between top of observation port and water surface level during dry and wet weather. During rainy weather, the water level will rise within the observation port. However, after the rain event has ceased, the water level at the observation port will drop as the water drains out of the pavement section. If water does not drain out of the observation port after 72 hours after rain has ceased, then the pavement base materials may be clogged or the groundwater table is high.
Inspect system for clogging	<ul style="list-style-type: none"> Inspect for ponding water (clogging) after heavy rain events (more than 1 in. of rainfall in 24 hours). Inspect pavement in early fall. 	<ul style="list-style-type: none"> Check for clogging and reduced permeability. If clogged, clean pavement as described below. If inspecting during dry weather, spray water (e.g., use garden hose) onto areas that appear clogged. If water runs off and does not filter into the pavement, pavement may be clogged. Implement cleaning measures to remove sediment such as using dry broom, pavement vacuum sweepers, or other tools. Remove finer debris with vacuum equipment. Follow manufacturer guidelines for when vacuuming is most effective (e.g., when pavement is dry). With open-celled paver systems, remove debris as described above and replace gravel.
Permeable cement and porous asphalt		
Manually sweep large debris and leaves	Once per year in fall or as needed.	<ul style="list-style-type: none"> Sweep porous pavement manually to maintain appearance and remove large debris such as leaves from pavement. Sweep and rake leaves as soon as leaves drop, preferably when surface and debris is dry.
Vacuum sweep	Vacuum sweep twice per year.	<ul style="list-style-type: none"> Keep porous pavement surfaces clean to decrease sediment clogging. Vacuum sweep porous pavement to maintain appearance, remove sediment, and provide positive infiltration through pavement. Sweep porous pavement to maintain appearance and remove leaves and other debris as required to maintain positive infiltration rate.
Moss removal	As needed if water is unable to infiltrate through the moss covering.	<ul style="list-style-type: none"> Moss is a common occurrence in the Pacific Northwest. Some moss will not affect the overall performance of porous pavement; however, if it grows thick and covers a large area, it can possibly reduce infiltration rates. Test infiltration and removal techniques on a small area before proceeding. Use any of the following options: scrubber washing, weed burner, sweeping, vacuum sweeping, or a combination of all.
Trim ground covers along porous pavement edge	Bimonthly (minimum) from March–September.	<ul style="list-style-type: none"> Regularly trim plants along porous pavement edge. Time trimming as needed to keep plants from rooting in adjacent porous pavement. Replace invasive ground covers with non-invasives and re-establish plantings.
Porous pavement restoration	5–30 years.	<ul style="list-style-type: none"> If wearing course needs to be replaced, remove wearing course and reinstall porous pavement section. Review with geotechnical engineer if original subbase can be reused for the pavement section or repair/replace as needed.

Table 4-57. Permeable Pavement Routine Maintenance General Work Method

Maintenance Activity	Recommended Frequency	Notes
Permeable Pavers		
Moss removal	As needed if water is unable to infiltrate through the moss covering.	<ul style="list-style-type: none"> Moss is a common occurrence in the Pacific Northwest. Some moss will not affect the overall performance of permeable pavers; however, if it grows thick and covers a large area, it can possibly reduce infiltration rates. Test infiltration and removal techniques on a small area before proceeding. Use any of the following options: scrubber washing, weed burner, sweeping, vacuum sweeping, or a combination of all.
Manually sweep large debris and leaves	Once per year in fall or as needed.	<ul style="list-style-type: none"> Sweep manually to maintain appearance and remove large debris such as leaves from pavement. Sweep and rake leaves as soon as leaves drop, preferably when surface and debris is dry.
Vacuum sweep	Vacuum sweep twice per year.	<ul style="list-style-type: none"> Keep surfaces clean to decrease sediment clogging. Vacuum sweep to maintain appearance, remove sediment, and provide positive infiltration through pavement.
Vegetative Paver System		
Mow	As needed to maintain a height of 3 in. (usually 1 time per week during summer).	<ul style="list-style-type: none"> Mow with a mulching mower. Clippings can be left in place.
Open Celled Pavers – Gravel		
Remove trash and debris	<ul style="list-style-type: none"> Remove trash and debris. Inspect after large storm events (~ more than 1 in. of rainfall in 24 hours or heavy downpour). 	<ul style="list-style-type: none"> Collect and properly dispose of trash/litter. Pet waste is a serious concern and should not be left within a pavement system as it contains disease-causing organisms and flushes bacteria into the stormwater.
Weed	Bimonthly from March–October.	<ul style="list-style-type: none"> Remove weeds manually by roots with pincer-type weeding tools, or hot water weeders.
Sweep gravel	Once per month or as needed.	<ul style="list-style-type: none"> Remove and dispose of litter/debris and sweep clean gravel back into gravel pavers areas.
Topdress gravel	Inspect for bare spots and areas of disturbed vegetation every 6 months.	<ul style="list-style-type: none"> Refill cells with clean gravel per original designs to top of or slightly above geogrid surface. Follow manufacturer's guidelines for repair of structural components of pavement system grid.
Check for cracking, settlement, or structure damage	Inspect once per year or as needed.	<ul style="list-style-type: none"> Replace the confinement cells if damaged. Follow manufacturer guidelines for replacing sections of cells.

Regional Road Guidelines BMPs for permeable pavement construction including installation, repair, and replacement are included in Table 4-58 Tri-County Working Group 2000).

Table 4-58. Permeable Pavement Construction Regional Road Guidelines BMPs	
Name	BMP Number
Dust control	2.61
Inlet protection	2.79
Concrete containment (1)	2.34
Concrete containment (2)	2.37
Sweeping	2.152
Vactoring	2.166

4.22 Pipe

Pipes provide conveyance of stormwater to other structures including catch basins, manholes, vaults, tanks and ponds.

Related SOPs include control structure, catch basin, manhole, and ditch. Figure 4-19 shows pipe used as a flow control device.



Figure 4-19. Pipe

4.22.1 Pipe Inspection

Visual pipe inspection is accomplished by a variety of methods that include simply looking into the end of a pipe (i.e., candling) using a pole-mounted zoom camera, or a CCTV inspection device. Pipes adjacent to ditches or serving as driveway culverts are visually inspected. Pipes less than 8 inches (in.) are likely to have blockages and may be more difficult to clean because of the size of vacuum equipment. Pipes less than these sizes and lengths either pose too low of risk to warrant the cost of inspection/cleaning, or can be done via candling (e.g., driveway culverts). Table 4-59 is a summary of the Cityworks custom inspection observation form for pipes with a visual inspection.

Table 4-59. Pipe Cityworks Inspection Form (non-CCTV inspection) with Inspection General Work Method

Criterion	Result	Explanation	General Inspection Method
Sediment	FAIL	Greater than 33% of pipe diameter	Use graduated rod or measuring tape to measure sediment depth and outfall pipe diameter to estimate the percent of sediment of cross sectional diameter at pipe outlet.
	PASS	Less than 33% of pipe diameter	
Vegetation	FAIL	Blocking free movement of water	Visual inspection of vegetation at pipe inlet or outlet.
	PASS	Not blocking free movement of water	
Dent	FAIL	Greater than 20% reduction in cross-section area	Visual inspection and estimation of dent cross section area, relative to pipe cross-section area.
	PASS	Less than 20% reduction in cross-section area	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen or by smell of contaminants such as petroleum products or organic compounds (e.g., paint thinner or acetone) within the culvert included above the current water level. Visual inspection of discolored or soapy water. Visual inspection of oily sheen in pipe. Visual inspection of discolored or soapy water.
	PASS	Oil/gas/other pollution absent	
Trash and debris	FAIL	Blocking Inlet/outlet	Visual inspection of trash and debris at pipe inlet or outlet.
	PASS	Not blocking Inlet/outlet	
Cannot Locate	FAIL	Cannot locate	Visual inspection for locating relative to map/GIS representation and identifier.
	PASS	Can locate	
Other	FAIL	Other, comment	"Other, comment" means any condition that requires attention to remain or be returned to operation.
	PASS	None	

Pipes are inspected with CCTV inspection equipment to investigate pipe failure or a basin-wide condition assessment inspection. These pipes are inspected on a 20-year cycle and use the National Association of Sewer Service Companies (NASSCO) Pipeline Assessment and Certification Program (PACP) structure and maintenance scoring system. PACP-certified inspectors populate an inspection results database while viewing CCTV pipe inspection video. Cityworks has a CCTV interface for a PACP add-on feature that allows Cityworks to read directly from a PACP database. PACP inspection procedures are a repeatable inspection process that documents the condition of the pipe in a standard fashion to allow an assessment of degradation over time and comparison of assets against each other.

4.22.2 Pipe Maintenance and Construction BMPs

Table 4-60 summarizes the maintenance activities for pipes.

Table 4-60. Pipe Maintenance Summary	
Element	Description
Maintenance timing	Pipe cleaning is done primarily during dry months to avoid washing turbid water downstream. Routine work is scheduled for the driest periods to optimize sediment removal and minimize possible water quality impacts. If there is work conducted during wet periods or flowing water, the work is performed via vactor truck with vactoring occurring downstream of pipe work to control the escape of sediment-laden water.
Maintenance type	Pipes are cleaned using a vactor truck to flush the lines using a hose-mounted jetting head. Built-up roots are removed with a vactor truck and a hose-mounted root cutter.
Reactive maintenance	CIPP is the preferred pipe repair method to address cracks, small holes, and joint displacements for end-to-end pipe lengths. Severe defects, such as deformation, large holes, and large displacements require open-cut replacement of the damaged portion.
Permit requirements	Pipes are not directly required to be cleaned or inspected as part of the NPDES permit.
Exceptions and outliers	There are pipes 6 in. and under at several locations in the city. Conventional vactor equipment may be too destructive to clean these small-diameter pipes. Blind connections between pipes exist and should be replaced with a basin/manhole if discovered.

Regional Road Guidelines BMPs for pipe construction including installation, repair, and replacement are included in Table 4-61 (Tri-County Working Group 2000).

Table 4-61. Pipe Construction Regional Road Guidelines BMPs	
Name	BMP Number
Inlet protection	2.79
Sandbag	2.109
Dewatering	2.5

4.23 Pipe Inlet Structure

Pipe inlet structures (i.e., trash racks) are typically a grated structure that limit unauthorized and unwanted access to a drainage structure of debris or larger animals.

Related SOPs include control structure, pipe, and ditch. Figure 4-20 shows a typical pipe inlet structure.



Figure 4-20. Pipe inlet structure

4.23.1 Pipe Inlet Structure Inspection

Pipe inlet structure inspection and repair are typically initiated through Cityworks work orders. Table 4-62 is a representation of the CMMS inspection checklist in Cityworks for drains.

Table 4-62. Pipe Inlet Structures Cityworks Inspection Form with Inspection General Work Method			
Criterion	Result	Explanation	General Work Method
Trash/debris	FAIL	Trash or debris plugging greater than 20% of openings	Visual inspection of trash or debris plugging opening. Visually estimate the percent blockage.
	PASS	Trash or debris plugging less than 20% of openings	
Structure	FAIL	Structure is bent, missing pieces or not attached	Visual inspection of structure condition.
	PASS	Structure is not bent, is intact and attached	

4.23.2 Pipe Inlet Structure Maintenance

Pipe inlet structures should be free of trash or debris. The structure should be whole and not deformed.

Table 4-63 summarizes maintenance for pipe inlet structures.

Table 4-63. Pipe Inlet Structure Maintenance Summary	
Element	Description
Maintenance timing	Pipe inlet structure maintenance is done primarily during dry months to avoid washing turbid water downstream. Pipe inlet structures are typically maintained when associated ditch and culvert assets are maintained.
Maintenance type	Routine maintenance includes removing trash or debris from opening. Vegetation control occurs only if inlet opening and inflow is blocked by vegetation.
Reactive maintenance	Reactive maintenance includes the repair of severe defects, such as missing, bent or unattached structures. displacements require open-cut replacement of the damaged portion. Maintenance efforts to address conditions such as damage from storms (sediment), car accidents, pollutant spills, or construction may require special repairs or cleanup.
Permit requirements	Permit regulations related to ditches focus primarily on the inlet and outlet. However, when an inspection identifies an exceedance of the maintenance standard, maintenance shall be performed within 1 year for typical maintenance and within 2 years for maintenance that requires capital construction of less than \$25,000. In addition, there may be HPA requirements if the ditch is classified as a stream.

4.24 Pond

Ponds are natural or constructed open-detention features that provide water quality benefits from habitat and sediment settlement.

Related SOPs include control structure, dam, gate valve, natural channel, and stormwater facility. Figure 4-21 shows a detention pond.



Figure 4-21. Pond

4.24.1 Pond Inspection

Ponds are inspected annually and typically in coordination with other assets associated with a stormwater facility.

Table 4-64 is a representation of the CMMS inspection checklist in Cityworks for ponds. The form is a simplification of Table V-4.5.2(1) “Maintenance Standards – Detention Ponds” and Table V-4.5.2(11) “Maintenance Standards – Wetponds”, Section 4.6, Volume V of 2014 SWMMWW, included in Appendix B.

Table 4-64. Pond Cityworks Inspection Form with Inspection General Work Method

Criterion	Result	Explanation	General Work Method
Sediment	FAIL	Greater than 10% of designed pond depth	Estimate depth of sediment from linked design drawings.
	PASS	Less than 10% of designed pond depth	
Rodent holes	FAIL	Located on dam or located on berm	Visual inspection of dam and berm.
	PASS	Not located on dam and not located on berm	
Emergency spillway	FAIL	Missing rock	Visual inspection of rock at spillway.
	PASS	No missing rock	
Poisonous/ invasive vegetation	FAIL	Restricting access or noxious weeds present	Visual inspection of weeds or access limited by invasive plants.
	PASS	Unrestricted access and noxious weeds absent	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen on water, pond bank or tributaries or by smell such as petroleum products or organic compounds (e.g., engine oil, paint thinner or acetone). Visual inspection of discolored or soapy water.
	PASS	Oil/gas/other pollution absent	
Tree growth	FAIL	Inhibiting access or present on bank/berm	Visual inspection of tree growth on bank/berm and access areas.
	PASS	Not Inhibiting access, and absent on bank/berm	
Slope erosion	FAIL	Present	Visual inspection of slope erosion. Look for bare dirt or new bare areas on slope.
	PASS	Absent	
Inlet/outlet	FAIL	Blocked	Visual inspection of pond inlet and outlet.
	PASS	Clear	
Access road	FAIL	Passable	Visual inspection of access to, from, and on access road.
	PASS	Impassable	
Trash and debris	FAIL	Greater than 1 ft ³ /1,000 ft ²	Visual estimate of trash and debris on pond surface, bank, or access areas.
	PASS	Less than 1 ft ³ /1,000 ft ²	
Cannot locate	FAIL	Cannot locate	Visual inspection for locating relative to map/GIS representation and identifier.
	PASS	Can locate	
Other	FAIL	Other, comment	"Other, comment" means any condition that requires attention to remain or be returned to operation.
	PASS	None	

4.24.2 Pond Maintenance

Table 4-65 summarizes the maintenance of ponds.

Table 4-65. Pond Maintenance Summary

Element	Description
Maintenance type	Primary maintenance requires sediment removal from stormwater assets and vegetation control to allow for clear access and flow.
Maintenance timing	Maintenance work on ponds is done primarily during dry months. Sediment removal should be done in July or August with no flowing water, and no rain expected during the work window. If necessary, erosion control materials should be used above the ordinary high water mark where soils are exposed. Clearing of grates, inlets, and outfalls may occur year-round.
Reactive maintenance	Ponds may have many types of stormwater assets contained within them. Most reactive maintenance relates to the individual assets. There may also be site-specific maintenance such as tree removal and fence repair.
Permit requirements	Ponds must be inspected annually and after a 10-year rain event.

Table 4-66 presents a general work method for pond maintenance.

Table 4-66. Pond Maintenance General Work Method	
Activity Component	Activity Details and Description
Desired result	Remove noxious weeds, contamination, and pollutant materials from the pond. Clean inlets and outlets. Remove vegetation, grass, leaves, debris, and trees by hand or use machinery.
Resources	<ul style="list-style-type: none"> • Crew: 2-person crew • Material: None • Equipment: <ul style="list-style-type: none"> • 1 dump truck • 1 service truck • 2 weed eaters • 1 chainsaw • 1 various hand tools • 1 track hoe with mower if needed • PPE (gloves, hardhat, safety glasses, rain gear, rubber boots, hearing protection) • Contractor/vendor costs: • Debris: decant spoils
General work method	<ol style="list-style-type: none"> 1. Place traffic control signs and safety devices as required at job site 2. Use proper PPE 3. Notify front desk who will email police, fire, and public works if access to road will be impacted 4. Inspect for illicit discharge or connection (SMC 13.10.320); if illicit discharge observed, initiate a water quality service request for IDDE investigation 5. Remove accumulated sediment in ditch that exceeds 10% of designed pond depth 6. Remove noxious vegetation which may constitute a hazard to City personnel or public according to applicable regulations 7. Clean inlets and outfalls if accumulated sediment is 20% or more of the pipe; if pipe needs rodding, initiate a rodding request 8. Remove debris from channels to provide adequate flow 9. Straw or seed as needed 10. Quarry rock outfalls and around outlet pipe from ditch as needed 11. Install waddles with stakes as needed 12. Clean up job site, tools, and truck 13. Remove traffic control signs and safety devices as required at job site 14. Notify front desk who will email police, fire, and public works that access to road has been returned 15. Accurately report in Cityworks

4.25 Pump Station

Pump stations collect water from large areas and are generally set in closed depressions; therefore, failure of a pump station poses risks to immediate properties. Pump stations are used to prevent flooding of private property and critical infrastructure. Pump stations have wet wells and/or ponds associated with them that act as sediment control and lessen the frequency that the pumps may turn on.

Related SOPs include control structure and stormwater facility. Figure 4-22 shows pump station 26.



Figure 4-22. Pump station

4.25.1 Pump Station Inspection

Pump stations have several types of routine maintenance and inspections. During wet months, pump stations are inspected for flow and general operation on a weekly basis as a hot spot work order-based inspection. During dry months, pump stations are inspected before/during large rain events. Pump stations have comprehensive system inspections on an annual basis performed by a specialist. Table 4-67 is a representation of the CMMS inspection checklist in Cityworks for pump station control. Included in the hot spot inspection work order is a reminder for the inspector to check the work complete box in the asset panel if the hot spot is left in functional condition.

Table 4-67. Pump Station Controls Cityworks Inspection Form with Inspection General Work Method

Criterion	Result	Explanation	General Work Method
Floats	FAIL	Broken, missing, or Nonfunctional	Visual inspection of floats.
	PASS	Intact, present, and functional	
Motor	FAIL	Nonfunctional or excessive noise	Auditory inspection of pump motor. Pump motor should be smooth and consistent. There should be no grinding or knocking noise.
	PASS	Functional and normal noise	
Pump inlet	FAIL	Blocked	Visual inspection of pump inlet of from any blockage.
	PASS	Clear	
Wetwell	FAIL	Excessive trash or debris	Visual inspection of excessive trash or debris inside the wet well.
	Pass	No excessive trash or debris	
Pump hours		Input pump hours	Inspector tests the pump by turning it on for a short period (less than 1 minute) (a.k.a. as “bump the pump”).
Other	FAIL	Other, comment	“Other, comment” means any condition that requires attention to remain or be returned to operation.
	PASS	None	

4.25.2 Pump Station Maintenance

Table 4-68 summarizes the maintenance for pump stations.

Table 4-68. Pump Station Maintenance Summary

Element	Description
Maintenance timing	Routine maintenance is conducted in the spring and fall. During the spring, all pump stations are reviewed for run time, general function, and inspected for maintenance (see Section 5.2 Hot Spot Inspections). In early fall (i.e., September) pump stations have the wetwell cleaned if necessary and any other maintenance is done at the same time.
Maintenance type	Routine maintenance is conducted in the spring and fall. During the spring, all pump stations are reviewed for run time, general function, and inspected for maintenance (see Section 5.2 Hot Spot Inspections). In early fall (i.e., September) pump stations have the wetwell cleaned if necessary and any other maintenance is done at the same time.
Reactive maintenance	<ul style="list-style-type: none"> At times, a pump may require major repair and need to be removed from the wetwell. Depending on the severity of the repair, the pump may have to be rebuilt at the contractor’s shop. The control panel may require maintenance of controls (etc.) contained within the electrical panel. Work will be completed by a contractor. Other assets related to the pump station may require maintenance such as pipe repair. Please see specific asset descriptions for more information.
Permit requirements	Facilities must be inspected annually and after a 10-year rain event. When an inspection identifies an exceedance of the maintenance standard, maintenance shall be performed within 1 year for typical maintenance and within 2 years for maintenance that requires capital construction of less than \$25,000. Catch basins within regional facilities must have maintenance conducted within 6 months.
Exceptions and outliers	<ul style="list-style-type: none"> Pump stations collect water from large areas and are the lowest point water can reach without physical movement; therefore, failure of a pump station poses risks to immediate properties. Pump station failure and downtime poses significant risk to public safety and property damage. Pump stations may be part of a regional facility and must be maintained and inspection on a site-by-site basis. Because these sites are expansive and complicated, efficient use of contracted work in conjunction with City crews is vital for continuous operation.

4.26 Stormwater Facility (General Site Conditions)

Stormwater facilities are regional or residential facilities that are inspected and maintained by the Utility. Regional facilities receive large amounts of stormwater from the ROW. Residential stormwater facilities control stormwater for homes on separate tax lots that have also granted easements to the City. Both the regional and residential stormwater facilities operate with a variety of assets and associated grouping of assets that are intended to treat, control, or convey water collected from a large area. Stormwater facilities include pump stations, dams, large stormwater vaults/tanks, bioretention facilities, and large collections of other stormwater assets.

SOPs associated with stormwater facilities include catch basin, control structure, dam, gate valve, manhole, pond, pump, and vault/tank. Figure 4-23 shows the site security measures and general conditions surrounding a pump station facility.



Figure 4-23. Stormwater facility

4.26.1 Stormwater Facility Inspection

Stormwater facilities are inspected on an annual basis and are maintained as needed. The assets associated with the facility are included in the annual inspection. In addition, there are facilities that require vegetation maintenance more than once per year. Table 4-69 is a representation of the CMMS inspection checklist in Cityworks for stormwater facilities.

Table 4-69. Stormwater Facility Cityworks Inspection Form with Inspection General Work Method

Criterion	Result	Explanation	General Work Method
Vegetation	FAIL	Overgrown, restricting access, or noxious weeds present	Visual inspection of weeds or access limited by invasive plants.
	PASS	Not overgrown, unrestricted access, and noxious weeds absent	
Trash and debris	FAIL	Present	Visual inspection of trash and debris.
	PASS	Absent	
Fence	FAIL	Broken or missing	Visual inspection of fence. Walk perimeter.
	PASS	Intact, present, and functional	
Gate	FAIL	Broken or missing	Visual inspection of gate.
	PASS	Intact, present, and functional	
Locks	FAIL	Broken or missing	Visual inspection of locks.
	PASS	Intact, present, and functional	
Signs	FAIL	Broken, missing, or not visible	Visual inspection of signs.
	PASS	Intact, present, and visible	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen on surfaces near surface water sources or by smell of petroleum products or organic compounds (e.g., paint thinner or acetone). Visual inspection of discolored or soapy water.
	PASS	Oil/gas/other pollution absent	
Other	FAIL	Other, comment	"Other, comment" means any condition that requires attention to remain or be returned to operation.
	PASS	None	

4.26.2 Stormwater Facility Maintenance

Table 4-70 summarizes maintenance for stormwater facilities.

Table 4-70. Stormwater Facility Maintenance Summary

Element	Description
Maintenance timing	Maintenance timing will be based on the timing requirements of the associated facility outlets.
Maintenance type	Primary maintenance requires sediment removal from stormwater assets and vegetation control to allow for clear access and flow.
Reactive maintenance	Regional facilities may have many types of stormwater assets contained within them; therefore, the most reactive maintenance relates to the individual assets. There may also be site-specific maintenance such as tree removal and fence repair.
Permit requirements	Regional facilities must be inspected annually and after a 10-year rain event.
Exemptions and outliers	These facilities can present many challenging situations that may need to be taken on a case-by-case basis. Each facility has site-specific design or layout plans and some have O&M manuals that describe maintenance pertaining to site needs.

4.27 Swale

Grass swales are densely vegetated trapezoidal or triangular channels designed to slow runoff, promote infiltration, and facilitate sedimentation while limiting erosion.

Relevant SOPs include bioretention facility and infiltration facility. Figure 4-24 shows the arrangement of a typical swale.



Figure 4-24. Swale

4.27.1 Swale Inspection

Swales are inspected annually and typically in coordination with other assets associated with a stormwater facility. Utility staff perform bioretention facility inspection and prepare corrective work orders for maintenance, repairs, and replacements.

Table 4-71 is a representation of the CMMS inspection checklist in Cityworks for bioretention facilities. The form is a simplification of Table V-4.5.2(8) “Maintenance Standards – Typical Biofiltration Swale” and Table V-4.5.2(9) “Maintenance Standards – Wet Biofiltration Swale”, Section 4.6, Volume V of 2014 SWMMWW, included in Appendix B.

Table 4-71. Swale Cityworks Inspection Form with Inspection General Work Method

Criterion	Result	Explanation	General Work Method
Sediment	FAIL	Greater than 2 in.	Visual inspection of thickest sediment deposits within the swale.
	PASS	Less than 2 in.	
Vegetation	FAIL	Blocking free movement of water	The facility should be free of weeds such as grass, ivy, dandelions, or non-design/post-construction plantings that would reduce facility function.
	PASS	Not blocking free movement of water	
Inlet/outlet	FAIL	Clogged with debris	Visual inspection of debris blockage at inlet/outlet.
	PASS	Clear	
Grass	FAIL	Greater than 10 in. high	Visual inspection of grass height.
	PASS	Less than 10 in. high	
Poor vegetation coverage	FAIL	Bare patches greater than 10% of swale bottom	Visual estimate of grass coverage of swale bottom.
	PASS	Bare patches less than 10% of swale bottom	
Erosion	FAIL	Bank, channel erosion present	Visual inspection of channelization in swale bottom.
	PASS	Bank, channel erosion absent	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen on soil or vegetation sources or by smell of petroleum products or organic compounds (e.g., paint thinner or acetone). Visual inspection of discolored or soapy water.
	PASS	Oil/gas/other pollution absent	
Flow spreader	FAIL	Not intact	Visual inspection of connection of flow spreader to swale.
	PASS	Intact	
Weir	FAIL	Not intact	Check pass or fail if swale has weir. If the weir would not cause water to pond behind it and slow water down, it is considered not intact.
	PASS	Intact	
Trash and debris	FAIL	Present	Visual inspection of debris accumulation within swale.
	PASS	Absent	
Cannot locate	FAIL	Cannot locate	Visual inspection for locating relative to map/GIS representation and identifier.
	PASS	Can locate	
Other	FAIL	Other, comment	"Other, comment" means any condition that requires attention to remain or be returned to operation.
	PASS	None	

4.27.2 Swale Maintenance

Table 4-72 provides summary information for swale maintenance.

Table 4-72. Swale Maintenance Summary

Element	Description
Maintenance interval	Swales shall be maintained monthly during the growing season (March–September).
Maintenance timing	Perform corrective maintenance within 1 year of inspection. Typical corrective maintenance includes, soil replacement, plant replacement, and underdrain flushing.
Maintenance type	Routine maintenance varies with the growing season and occurs as frequently as monthly. Several maintenance activities are especially prone to cause soil compaction. Avoid compacting soil during maintenance activities. Typical routine maintenance for Utility staff includes removing weeds, removing trash, and adding mulch.
Reactive maintenance	Maintenance efforts to address conditions such as damage from storms, car accidents, pollutant spills, or construction may require special repairs or cleanup.
Permit requirements	NPDES: Inspection must occur annually. If a swale does not meet a maintenance standard, general repairs must be made in 1 year and capital repairs in 2 years.

Table 4-73 provides a general work method for swale routine maintenance.

Table 4-73. Swale Routine Maintenance General Work Method		
Maintenance Activity	Recommended Frequency	Notes
Inspect inflow and outflow points for clogging	<ul style="list-style-type: none"> Monthly and as needed during wet season 	<ul style="list-style-type: none"> If observed, remove sediment at surface, in pre-settling areas and at storm structure outfalls. Remove any accumulated debris from inflow/outflow points (curb cuts, pipes, trench drains, storm structures, etc.).
Watering during first and second growing seasons	<ul style="list-style-type: none"> In the first 6 weeks, plantings will require approximately 1 in. of water twice per week to establish deep roots. After watering, confirm the soil is moist 3–6 in. below surface. Reduce watering frequency to once a week until the end of the first growing season (May–September). 	<ul style="list-style-type: none"> Intent of watering is to keep plant material sustained through establishment. Monitor rainfall to determine irrigation/watering schedule. Water regularly during the first two growing seasons. Dry periods will need additional watering for establishing plants because of warmer temperatures and increased sunlight—both of which can stress vegetation. Wilted leaves and drooping stems are all indications of stress caused by dry soils and hot temperatures. Optimal watering time is early in the morning or late in the evening to reduce evaporation. A preferred watering approach is to have repeated short cycles of watering and soaking into the ground. Follow manufacturer's guidelines for O&M of irrigation system and its components.
Dry period watering for established bioretention	<ul style="list-style-type: none"> Water infrequently but thoroughly: 0.5 in. – 1.0 in. every 2 weeks or when plants appear stressed. Monitor rainfall and check weather updates and adjust watering accordingly. 	<ul style="list-style-type: none"> Established (more than 2 years) drought-tolerant plants may need water during prolonged dry periods (possibly late July–mid-September). Inspect plantings during dry periods and look for signs of stress. Verify if any watering restrictions are in effect in the city for watering during dry periods/water shortages. If no restrictions, then note the following: Optimal watering time is early in the morning or late in the evening to reduce evaporation. Monitor rainfall to determine an irrigation schedule. Do not apply water faster than the soil can absorb it. Deeper and less frequent watering will encourage plants to develop a deep root system. If present, inspect irrigation system components for breaks and blockages and repair as necessary.
Leaf, branch, and organic matter removal	<ul style="list-style-type: none"> Inspect for organic matter or debris that are blocking inflow points or structures and causing ponding water. Schedule frequent leaf removal in fall. Frequent mowing may be required from spring–mid-July for turf swales. Monthly mowing may be required July–mid-November for turf swales. 	<ul style="list-style-type: none"> To prevent clogging, larger pieces of biodegradable landscape debris should be mulched or collected for composting, green waste pick up, or disposal to a recycling facility. Maintaining a minimum height of 4 in. for turf grass within bioretention facilities (turf) will reduce weed invasion and encourage deep root growth, which strengthens drought resistance. Mow with a mulch mower when 10 in. or greater. Sharpen mower blades frequently to reduce ragged cutting. A thick layer of leaves, branches, and trash can prevent water and light from getting to lawn and other landscaped areas. Excessive leaf litter around plantings can provide cover for pests and allow mildew growth. Mulching organic matter (leaves) is recommended to facilitate decomposition for both turf and vegetated swales.
Trash and debris removal	<ul style="list-style-type: none"> Remove trash and debris. Inspect after large storm events (~more than 1 in. of rainfall in 24 hours or heavy downpour). 	<ul style="list-style-type: none"> Collect and properly dispose of trash/litter. Pet waste is a serious concern and should not be left within a swale as it contains disease-causing organisms and flushes bacteria into the stormwater.

Table 4-73. Swale Routine Maintenance General Work Method

Maintenance Activity	Recommended Frequency	Notes
Pruning and removal of dead material	<ul style="list-style-type: none"> In spring, remove dead or old plant material from previous season. Mid-summer and fall, inspect and cut back any plant material that blocks sidewalks and utilities. In fall, prune to maintain plant appearance. 	<ul style="list-style-type: none"> Trim and thin vegetation from prior season's growth, leaving 6–8 in. Allow dormant vegetation and old flower stalks to remain in winter to provide food and cover for birds. For early blooming shrubs/trees, prune in spring following bloom. Plants may require pruning, pinching, and dead heading during the growing season to promote reflowering, direct growth, etc. Native and/or ornamental grasses may appear dead but generally these plants are dormant during the winter months. Do not remove, prune dry material in spring as new material emerges. If appear dead in mid-summer, remove and replace.
Weed control of invasive vegetation/weeds	<ul style="list-style-type: none"> Remove as soon as observed. During 3-year establishment period, inspect at least once per month in growing season. Inspect at least 3 times per year once plants are established. 	<ul style="list-style-type: none"> Pay special attention to nuisance and invasive vegetation before it establishes a foothold. Particular threats to wet areas are reed canary grass and Japanese knot weed. Other threats include clover, scotch broom, horsetail, morning glory, alder seedlings, English ivy, and blackberry. Watch for any signs of these plants and remove them, including root system. Persistent and invasive vegetation that is located in a mass can be killed by covering the area with black plastic for several weeks during summer.
Weed control of non-invasive vegetation/weeds	<ul style="list-style-type: none"> Inspect the full bed and remove weeds February, June, and September. Minor weeding monthly. See mulch section of this manual for more information to reduce weed establishment. 	<ul style="list-style-type: none"> Remove weeds manually before they go to seed by using pincer-type weeding tools, hoes, or hot water weeders. Remove the roots for best results. Weeds should be pulled when first observed and especially before they go to seed. Weeds need to be pulled in early spring so that the desired plants can thrive. Mulch immediately (no more than 5 days) following weeding to improve weed control. When dealing with invasive plant material/weeds, attempt all other physical methods to remove before considering a more aggressive method. It is important to note that chemicals can harm or kill beneficial or desirable plants, and also add pollutants to stormwater that can negatively impact water quality.
Bare spots and vegetation removal and replacement	<ul style="list-style-type: none"> Inspect for bare spots and areas of disturbed vegetation every 6 months. 	<ul style="list-style-type: none"> Plants may die because of unsuitable conditions or microclimates, disease, pests, or other unforeseen issues. These plants must be removed/replaced to avoid the establishment of weeds in bare areas, the spread of disease, and the reduction in functionality. Reseed or replant bare areas and replace poor performing plants. Vegetation should cover 90% of swale. Replace vegetation with in-kind planting material or replace plants with high mortality rate with appropriate plants. Maintain 1 ft zone clear of vegetation around all inlets and outlets.
Mulch	<ul style="list-style-type: none"> Add wood chip mulch in fall and/or spring. Replace or add wood chip mulch as needed to maintain 2–3 in. depth. 	<ul style="list-style-type: none"> 1 cubic yard of mulch will cover 100 ft² at a depth of 3 in. 1 cubic yard = 27 ft³. Commercial mulch products generally are available in 2 cubic foot bags. 13.5 bags = 1 cubic yard. Wood chip mulch helps to control weeds, conserve soil moisture, improve filtration, regulate soil temperatures and adds nutrients to the soil as it decomposes.
Sediment removal	<ul style="list-style-type: none"> Late fall and late spring. After heavy downpour and rain events of 1 in. or more precipitation in 24-hour period. 	<ul style="list-style-type: none"> If more than 2 in. accumulation, remove sediment preferably when the swale is dry. Remove sediment manually, using shovels or rakes. Dispose of sediment in accordance with local requirements. Replace damaged or destroyed vegetation with in-kind plant material.

Table 4-74 provides a general work method for swale triggered maintenance.

Table 4-74. Swale Triggered Maintenance General Work Method		
Triggered Maintenance	Condition Observed	Instructions
Ponding water	<ul style="list-style-type: none"> Water is standing/ponding in swale and not draining within 48 hours after the rain event has stopped. The facility is not functioning properly due to blockage of sediment and/or debris in the soil strata, underdrain or outlet structures. 	<ul style="list-style-type: none"> Check observation port, if available, to determine if underdrain pipe is blocked. Remove debris. Check surface overflow, outlet pipe, or structure to determine if blocked. Remove debris. May need suction vacuum. The soil may also be blocked by fine sediments. Rake mulch layer aside and remove sediment from top surface layer, aerate soil, and respread mulch.
Erosion of soils and sediment loading	<ul style="list-style-type: none"> 2 in. (or greater in depth) gullies/rills are present, washing out soils and mulch. Sediment washed downstream is clogging outlets and/or rock around outlet structures. 	<ul style="list-style-type: none"> Remove and store any desirable vegetation (to be used for replanting) from swale. Rake and remove fine sediments from surface. Add additional soil if necessary and regrade to direct water toward low point of swale, or level out bottom surface. Replant and/or replace vegetation and reapply mulch. If slopes have been compromised, remove vegetation (reserve for replanting), re-grade, and re-contour area by hand tools where practical. Replant vegetation and install 2–3 in. of mulch. Clear away rocks, sediment, and reinstall rock protection at structure inlets/outlets and add more rocks if needed.
Soil settlement	<ul style="list-style-type: none"> Soil has settled 2+ in. below paving surface. 	<ul style="list-style-type: none"> Rake mulch aside for later use. Apply prepared swale soil mix (use soil mix design per original plans if possible or see reference below for information) to bring soil height within 1–2 in. of top of pavement. Add 1–2 in. of mulch to bring top of mulch flush with adjacent paving/surface. Replant if necessary to provide vegetative cover over exposed soil.
Pest control	<ul style="list-style-type: none"> Pests have been reported to cause extensive plant damage or death and have/could become a nuisance or public health concern. Mosquitoes can breed in shallow stagnant ponding water. 	<ul style="list-style-type: none"> Remove all trash, fruit, and nuts that have fallen to the ground to avoid attracting rodents. Mosquito larvae look like “wiggling sticks” typically floating perpendicular to water’s surface. Mosquitoes take 5–7 days to mature. Swales are designed to drain out within 24–48 hours after the rain event has ceased. If stagnant ponding and larvae are observed, then remove ponding. Where rodent holes are present, fill with soil, and lightly compact soil around the holes.

4.28 Vault and Tank

Vaults and tanks are used primarily as a means of flow and sediment control. These facilities function by storing large volumes of water and metering the release of water. As water is stored, sediment suspended in the water column can settle. These facilities do not treat soluble constituents such as household chemicals and metals.

Relevant SOPs include control structure, filter, and oil/water separator. Figure 4-25 shows a typical vault/tank.



Figure 4-25. Vault/tank

4.28.1 Vault and Tank Inspection

Vault and tank inspections are performed as part of Stormwater Facility inspections; they are inspected for sediment accumulation and other maintenance deficiencies. Inspection generally includes assets such as a control structure.

Table 4-75 is a representation of the CMMS inspection checklist in Cityworks for vaults and tanks. The form is a simplification of Table V-4.5.2(3) “Maintenance Standards – Closed Detention Systems (Tanks/Vaults)” and Table V-4.5.2(12) “Maintenance Standards – Wetvaults”, Section 4.6, Volume V of 2014 SWMMWW, included in Appendix B.

Table 4-75. Vault and Tank Cityworks Inspection Form with Inspection General Work Method

Criterion	Result	Explanation	General Work Method
Sediment	FAIL	Greater than 10% of the tank diameter for half the length of storage area, or greater than 15% at any point	Use graduated rod to estimate sediment depth, inlet/outlet pipe diameter and vault depth and diameter. Example 1: A 72 in. diameter storage tank would require cleaning when sediment reaches a depth of approximately 7 in. for more than half the length of the tank. Example 2: A 72 in. storage tank would require cleaning when sediment at any point reaches a depth of approximately 11 in.
	PASS	Less than 10% of the tank diameter for half the length of storage area, and less than 15% at any point	
Air vents	FAIL	Blocked or bent	Visual inspection of vents for blockage or bent condition.
	PASS	Not blocked and not bent	
Grout fillet (pipe to wall)	FAIL	Cracks wider than 0.5 in. with evidence of soil particles entering the structure	Visual inspection of the connection of pipes to vault or tank wall. Visually estimate width and length of cracks with graduated rod or tape measure.
	PASS	Cracks less than 0.5 in. with no evidence of soil particles entering the structure	
Vault structure wall/bottom/side/slab/frame	FAIL	Cracks wider than 0.5 in. with evidence of soil particles entering the structure	Visual inspection of walls, bottom, side, slab and frame concrete, missing bricks or large cracks. If bottom is covered with sediment, flag catch basin for inspection during cleaning.
	PASS	Cracks less than 0.5 in. with no evidence of soil particles entering the structure	
Contamination	FAIL	Oil/gas/other pollution present	Visual inspection of oily sheen or by smell of contaminants such as petroleum products or organic compounds (e.g., paint thinner or acetone) within the vault/tank including on top of water or sediment, or along the interior wall. Visual inspection of discolored or soapy water.
	PASS	Oil/gas/other pollution absent	
Inlet/outlet	FAIL	Blocked	Visual inspection of inlet and outlet for blockage.
	PASS	Clear	
Trash and debris	FAIL	Present	Visual inspection for trash and debris within the vault or tank.
	PASS	Absent	
Cannot locate	FAIL	Cannot locate	Visual inspection for locating relative to map/GIS representation and identifier.
	PASS	Can locate	
Grate/cover	FAIL	Unable to open, missing, and/or broken	Inspector opens grate/cover to perform inspection.
	PASS	Able to open, present, and intact	
Other	FAIL	Other, comment	"Other, comment" means any condition that requires attention to remain or be returned to operation.
	PASS	None	

4.28.2 Vault and Tank Maintenance

Table 4-76 provides summary information for maintenance of vaults and tanks.

Table 4-76. Vault and Tank Maintenance Summary	
Element	Description
Maintenance type	Vault and tank maintenance is done during dry months to avoid washing of sediment-laden water downstream and ease the work process. Routine work is scheduled for the driest periods to optimize sediment removal and minimize possible water quality impacts. If there is work done during wet periods, water must be routed around the vault while the work is completed. If a significant rain event is predicted, the work must be postponed.
Maintenance timing	The primary means of maintenance is sediment removal. At junctures between tank and outfall structures there may be grouting repairs.
Reactive maintenance	Large CMPs may rust and need to be patched or replaced. Large tanks with structural repairs can be drained and repaired as needed.
Permit requirements	Facilities must be inspected annually and after a 10-year rain event. When an inspection identifies an exceedance of the maintenance standard, maintenance shall be performed within 1 year for typical maintenance and within 2 years for maintenance that requires capital construction of less than \$25,000.
Exceptions and outliers	Cleaning of a large vault can be expensive and time consuming. The cleaning interval may be decades apart. If a cleaning is to occur, then a thorough inspection should be conducted at the same time, bringing the entire structure up to full function.

Table 4-77 provides a general work method for the maintenance of vaults and tanks.

Table 4-77. Vault and Tank Cleaning General Work Method	
Activity Component	Activity Details and Description
Desired result	Storm vaults are cleaned and free of debris by vacuuming.
Resources	<ul style="list-style-type: none"> • Crew: 2-person crew • Material: Water • Equipment: <ul style="list-style-type: none"> • 1 vacor truck • PPE (gloves, hardhat, safety glasses, rain gear, rubber boots, hearing protection) • Laptop, charger, and cleaning sheets • Contractor/vendor costs: • Debris: decant spoils • City-approved decant location
General work method	<ol style="list-style-type: none"> 1. Place traffic control signs and safety devices as required at job site 2. Use proper PPE 3. Apply all confined space equipment 4. Crew members work together to position equipment, remove vault lid, and insert vacuum tube to clean sediment out of vault 5. Inspect for illicit discharge or connection (SMC 13.10.320); if illicit discharge observed, initiate a water quality service request for IDDE investigation 6. Crew cleans all areas within structure so that base of manhole is exposed; vacuum debris from tank/vault, and clean all surfaces, walls, brick, concrete, inlets, and outfalls 7. Inspect condition of inlet, outfall, and brick/concrete structure 8. Fill vault with water to operating level of vault 9. Replace and secure lid to avoid noise from traffic driving over it 10. Clean up job site, tools, and truck 11. Remove traffic control signs and safety devices as required at job site 12. Decant vacor truck in decant spoils bay 13. Make notes about any further work that is needed 14. Accurately report in Cityworks

Section 5

Other Surface Water Utility Responsibilities

This section provides information regarding other stormwater operations.

5.1 Commercial/Private Facility Inspections

The City's Commercial/Private Facility Inspections fall under element S.5.C.5, Municipal Operations and Maintenance of the NPDES Phase II Western Washington Municipal Stormwater Permit (Permit). The City of Shoreline currently inspects almost 300 private storm water facilities. The Permit requires that "inspections must be conducted annually unless there is sufficient data to justify a different frequency." The annual inspection schedule of a facility may be changed to a lesser frequency "based on maintenance records of double the length of time of the proposed inspection frequency." Based on an analysis conducted by the City, SWM staff currently inspects a total of 190 facility inspections conducted in even years and 187 facility inspections in odd years.

Currently, the City's Commercial/Private Facility Inspection program is based on compliance/enforcement through covenants and the City's Code for illicit discharges (SMC 13.10.320-13.10.340, SMC 20.30.720-790). See the Commercial/Private Facility Inspection Procedures in Appendix K for Cityworks work flow.

5.2 Easements and Covenants

The following section summarizes easements and covenants.

5.2.1 Easements

An easement is a portion of land for which the use has been granted to the public, corporation or person for a specific purpose. Easements related to the Utility are generally granted at the time of private property development. The easement recording documents dictate the responsibilities of the City and property owner and contain language describing access, conveyance, and maintenance of stormwater assets contained within the property boundary and subsequent easement. Because each easement is unique, it is recommended the City staff do the following prior to accessing an easement:

- Read the easement language to verify that all special restrictions and requirements are understood prior to proceeding with access or maintenance activities.
- Even if notification is not required, it is good practice to attempt to contact the property owner or tenant prior to exercising any easement rights.

In situations where no easement is available, complete a private access permission form contained in Appendix L.

5.2.2 Covenants

Covenant is a legal document between the city and persons holding title to the property requiring the title holder to perform required maintenance and repairs on drainage facilities necessary to meet the

city's specified standards within a reasonable time limit. Covenants is a development requirement in the Surface Water Code and EDM for private property development where stormwater assets are installed and must be maintained and includes a provision for City inspection.

Covenants are generally used to instruct a property owner of their obligations to maintain stormwater assets constructed as part of development for the property and as described in their associated maintenance manuals. The utility can use covenants to enforce the maintenance obligation to the property owner.

An example of a covenant is provided in Appendix M.

5.3 Hot Spot Inspections

The Utility performs hot spot inspections during the rainy season for facilities and locations that demonstrate flooding threat to private property, critical infrastructure, or the environment. These facilities include all of the City-operated pump stations, high-hazard dams, and areas prone to preventable flooding (clearing of basins, etc.). See Appendix N for the current list of surface water hot spots. Table 5-1 shows the current inspection frequency based on season and storm.

Table 5-1. Seasonal and Storm Triggered Hotspot Inspection Frequencies		
Season	Frequency	Storm Type
Summer	Monthly	Major storms
Mid-October-late February	Weekly	Moderate and major storms
Spring	Monthly	Major storms

Hot spots include sites such as high-hazard dams or pump stations will not be removed from the hot spot list for the foreseeable future. These sites require a physical site visit to confirm function of the facility and to ensure any maintenance is conducted. However, other sites that may be removed from regular inspection may be taken off the list after improvements have been made and the risk has demonstrably lessened.

General Guidelines for Initiating Hot Spots Inspections. During the rainy season (approximately October-February) the weather must be monitored closely to best judge when to conduct hot spot inspections. The following general guidelines can be used to determine when to conduct inspections.

- If an off season storm event is forecasted, hot spots should be checked prior to the event.
- During the transition from summer to fall, hot spots should be checked before we receive any significant rain.
- If approximately two inches of rain has fallen since the last inspections, inspect hot spots before the next forecast rainfall.
- If it is approaching the end of the work week and two inches of rain has not fallen since the last hot spot inspections, but we are expecting to accumulate the two inch threshold over the weekend, inspect hot spots prior to the beginning of the weekend.
- If we receive significant snowfall during the winter, inspect hot spots prior to and after the snowmelt.
- If high winds have occurred, inspect hot spots.

Procedure for Adding a Hot Spot. If we are alerted to or observe areas that continually experience flooding or standing water and have the potential to cause property damage or present a safety

issue, we may opt to temporarily or permanently add the area to the hot spot list. The following criteria will be considered when determining whether to add a new hot spot to the list.

- Identify the location of drainage issue
- Determine if there is stormwater infrastructure in the area
- Identify the cause of the issue or blockage
- Determine if it is an infrastructure blockage/clogging or capacity issue
- Determine if the issue can be resolved with routine maintenance
- New critical infrastructure is constructed (e.g. pump station or dam)

5.4 Illicit Discharge Detection and Elimination

Illicit Discharge Detection and Elimination (IDDE) investigations are a response to water quality service requests. Water quality service requests are generated from hotline calls as well as routine ROW, regional, residential, and commercial/private facility inspections. The investigation is a part of the Utility's ongoing IDDE program designed to prevent, detect, characterize, trace, and eliminate illicit connections and discharges into the City's stormwater drainage system.



Figure 5-1. Illicit discharge of wet concrete in manhole

5.4.1 IDDE Inspection and Investigation

IDDE inspection and investigation forms are initiated and completed as part of a Cityworks illicit discharge investigation work order. An inspection form is completed for each asset in which the illicit discharge is detected. Table 5-2 provides details regarding the Cityworks inspection checklist for IDDE.

Table 5-2. IDDE Cityworks Inspection Form with Inspection General Work Method	
Criterion	Result
Pollutant present	Yes
	No

Table 5-3 shows how the IDDE Cityworks *Work Order Investigative Form*, which is accessed electronically, might appear in hard copy format. Typically, one investigative form is completed for each incident.

Table 5-3. IDDE Cityworks Work Order Investigation Form		
Investigation Question	Selection	
1. How was incident discovered? (User chooses)	<input type="checkbox"/> Business <input type="checkbox"/> ERTS <input type="checkbox"/> Field investigation (explain) <hr/> <input type="checkbox"/> Interconnected MS4 referral <input type="checkbox"/> Multiple (explain) <hr/>	<input type="checkbox"/> O&M Inspection <input type="checkbox"/> Other (explain) <hr/> <input type="checkbox"/> Other agency <input type="checkbox"/> Other public <input type="checkbox"/> Pollution hotline <input type="checkbox"/> Staff referral
2. Explanation of how discovered/learned (User enters explanation)		
3. Source tracing method (User chooses)	<input type="checkbox"/> Dye testing <input type="checkbox"/> Multiple (explain) <hr/> <input type="checkbox"/> Other (explain) <hr/>	<input type="checkbox"/> Smell/odor <input type="checkbox"/> Smoke testing <input type="checkbox"/> TV'ing line <input type="checkbox"/> Visual ID <input type="checkbox"/> Water testing (explain) <hr/>
4. Explain tracing method (User enters explanation)		
5. Materials identified (User chooses)	<input type="checkbox"/> Construction waste <input type="checkbox"/> Dumping/ trash <input type="checkbox"/> Food waste/oil <input type="checkbox"/> Industrial waster <input type="checkbox"/> Multiple (explain) <hr/> <input type="checkbox"/> Natural source <input type="checkbox"/> None found	<input type="checkbox"/> Other (explain) <hr/> <input type="checkbox"/> Paint <input type="checkbox"/> Pet waste <input type="checkbox"/> Sediment/soil <input type="checkbox"/> Sewage/septage <input type="checkbox"/> soap/detergent <input type="checkbox"/> Vehicle fluids <input type="checkbox"/> Yard clippings
6. Explain materials identified (User enters explanation)		

Table 5-3. IDDE Cityworks Work Order Investigation Form

Investigation Question	Selection			
7. Property type of source? (User chooses)	<input type="checkbox"/> Commercial – Drive-thru <input type="checkbox"/> Commercial – Mobile business <input type="checkbox"/> Commercial – Other <input type="checkbox"/> Commercial – Restaurant <input type="checkbox"/> Commercial – Retail <input type="checkbox"/> Construction <input type="checkbox"/> Industrial <input type="checkbox"/> Multi-family <input type="checkbox"/> Multiple (explain) 	<input type="checkbox"/> Other (explain) <input type="checkbox"/> Public Entity <input type="checkbox"/> Residential <input type="checkbox"/> Source not identified <input type="checkbox"/> Vehicle		
8. Explanation of material source (User enters explanation)				
9. Corrective/elimination methods? (User chooses)	<input type="checkbox"/> Administrative action- legal notice <input type="checkbox"/> Administrative action – penalty or fine <input type="checkbox"/> Education/technical assistance <input type="checkbox"/> Multiple (explain) <input type="checkbox"/> No action needed (explain) 	<input type="checkbox"/> Other (explain) <input type="checkbox"/> Problem not abated (explain) <input type="checkbox"/> Source control BMP <input type="checkbox"/> Verbal notice <input type="checkbox"/> Written warning		
10. Explanation of correction and elimination (User enters explanation)				
11. Discharged continued threat? (User chooses)	<input type="checkbox"/> No	<input type="checkbox"/> Yes-G3/ERTS notifications		
12. Investigated with 7 days	<input type="checkbox"/> No	<input type="checkbox"/> No – document delay	<input type="checkbox"/> Referred	<input type="checkbox"/> Yes
13. Referred to: (User enters referral)				
14. Illicit connection discovered?	<input type="checkbox"/> NA	<input type="checkbox"/> No	<input type="checkbox"/> Yes	
15. Date connection discovered (User enters date)				
16. Investigated connection in 21 days?	<input type="checkbox"/> NA	<input type="checkbox"/> No	<input type="checkbox"/> Yes	
17. Final resolution (User enters final resolution)				

5.5 Pest and Animal Control

Shoreline has diverse animal fauna that from time to time may generate complaints from residents. The Utility does not act to control animals unless they pose a risk to life, public safety, or the integrity of public infrastructure.

In a life-threatening animal related emergency, call 9-1-1. For all other animal control related issues, contact the Regional Animal Services of King County at 206-296-7387. To the greatest extent possible, the Utility lets nature run its course within the built environment. Several examples are given below.

5.5.1 Animal Holes

When animal holes are discovered on the face of any dam, the animals are removed as appropriate to avoid risks to dam structural integrity and subsequent risks to life and public safety.

5.5.2 Beaver Management

Beavers damming up sections of Boeing Creek cause capacity issues at the outfall of Hidden Lake and threaten public infrastructure. This procedure is to define appropriate response to reports of beavers causing problems.

The presence of beavers is generally regarded as a sign of a healthy natural environment. However, there are occasions where allowing the population of beavers to grow and build dams could cause a threat to infrastructure, listed salmon, and/or public safety. When beaver-related issues arise, the following procedures are to be followed.

Criteria for Utility Response. The criteria for Utility response include:

- Existing or potential culvert blockage, and roadway or structure flooding.
- Significant migration blockage of Chinook salmon or other listed species to spawning habitat.
- A significant migration blockage is defined as the presence of migratory fish below the dam and not above because of the dam acting as a barrier to upstream navigation. Typically, these dams are greater than 3 to 4 feet high and have no side channels during high flow.

Note: Fish passage blockages associated with beaver activity usually occur where the natural stream channel is constrained and limited in width, and flows through a very low-gradient and wide-floodplain area with no side channels formed around the dam.

Criteria for Problem Identification. When a call or a report of a beaver dam is received, the following steps actions are to be taken:

- Identify location of problem and property address if available.
- If a dam is present, document the location.
- Determine if structures or roadways are at risk of flooding, and if those locations are public or privately owned.
- Determine if Chinook or other listed species migration routes are potentially being blocked.
- Determine if the public is in danger of falling trees from beaver damage close to trails, buildings, or roads.
- Determine the potential for damage from falling trees. If tree damage has occurred, identify the tree owner and attempt to notify of the situation. Share information with the owner appropriate for protecting trees (i.e., using wire mesh around the trunk).

When a beaver dam is on private property and only affecting the private property, information and advice should be shared with the property owner to assist with the permit acquisition process and

inform the property owner of other information and considerations that they should be aware of, such as fish passage, potential flooding, etc.

5.5.3 Wasps, Hornets, and Bees

When wasps, hornets, or bees are located within a ditch or other stormwater facility, action may be taken if they are threatening residents or if the ditch or other facility is scheduled for have maintenance.

5.5.4 Nuisance Wildlife Control

Beavers, coyotes, moles, mountain beavers, opossums, raccoons, waterfowl, and other species can be destructive to stormwater facilities, park lands, and natural areas when their activities are excessive. Generally, interference with wildlife is undesirable. If control of wildlife is deemed necessary, the City will work with the state agency (Department of Wildlife) to formulate a control solution.

Examples of past wildlife incidents for which City action was not required include:

- Otter is eating ducklings at Echo Lake: no risk to life, safety, or infrastructure.
- Raccoon or cat goes into pipe inlet and resident requests their removal or installing a trash rack: no risk to life, safety, or infrastructure. Animals generally vacate after a rain event.
- Beaver damming up section of McAleer Creek but impoundment is on private property and there is no risk of flooding to a living space: no risk to life, safety, or infrastructure.

5.5.5 Mosquito Control

For Mosquito Control, the City has adopted the most recent Best Management Practices for Mosquito Control developed by Ecology, and has an Aquatic Mosquito Control General Permit that allows for the management of mosquitos in the City stormwater facilities and within the City's ROW (Ecology 2004, 2015). All mosquito management activities must comply with the requirements of the current version of the Aquatic Mosquito Control General Permit, Phase II Permit, and State Waste Discharge General Permit issued by Ecology.

The City has developed an Integrated Mosquito Management Plan to guide staff on implementing BMPs to control adult mosquitos and how to document and report mosquito control implementation, see Appendix O.

5.6 Ronald Bog

Ronald Bog is a pond and wetland area at the headwaters of Thornton Creek. The Utility monitors the water level of the pond at the pond outlet pipe as part of its one flood warning system called the Ronald Bog Early Warning system located at Ronald Bog (adjacent to 2304 N 172nd Street). The system automatically updates a City website (City 2017) The website includes information related to the current bog level, alert activation, reverse 911, and flooding elevation. The flood warning system utilizes a pressure transducer system to correlate water elevations, which are triggered by predetermined status levels. If the monitor is triggered, the flood warning system begins automatically calling City staff until it receives confirmation and the alarm is turned off.

5.6.1 Ronald Bog Inspection

Key assets related to the flood warning system are monitored weekly as a hot spot inspection location from October to February—and periodically during dry months—including the drain pipe outlet, pump, and associated manholes and catch basins. Additional assets such as pipes, manholes, and catch basins are inspected annually as part of the regional inspection program for the larger Ronald Bog drainage area. Specific assets to be inspected or monitored for the hot spot and annual regional inspection are included in the respective work order forms.

5.6.2 Ronald Bog Emergency Flooding Plan

The following is an emergency plan for Ronald Bog during a large storm event. This section contains information on bog elevation, the early warning system, reverse 911, and the street pump system. Figure 5-2 shows the elevations of the monitoring system.

The Ronald Bog monitoring station can be viewed at the City website,

<http://www.shorelinewa.gov/government/departments/public-works/surface-water-utility/services/ronald-bog-early-warning>

or by calling 206.364.1868 and following these steps :

- Press 1 to hear the bog elevation
- Press 2 to hear the battery voltage

Normal levels are less than 365 feet with the alarm calling out at 365.1+ feet.

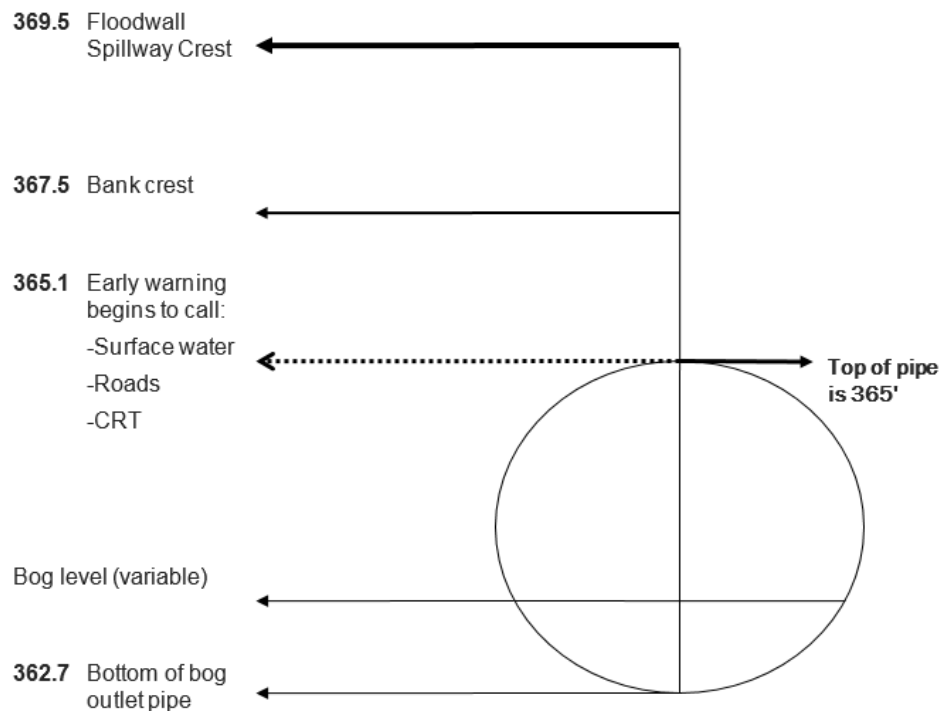


Figure 5-2. Ronald Bog key monitoring system elevations

What to Do if Bog Calls You:

- Follow the directions to hear the alert and water level:
 - Turn off alarm
 - Alert staff to monitor Bog
- You have 9-10 hours before the Bog may crest the floodwall spillway during high rainfall rates [Based on inflow rates analyzed from the December 3-4, 2007 rain event, it would take approximately 9-10 hours for the Bog level to crest the floodwall spillway. This calculation takes into account the highest observed flowrates from that storm over a 9-10 hour period]
- Activate Reverse 911 if there is an increasing risk of overtopping and local flooding

How to activate Reverse 911. Follow the directions to activate reverse 911:

- Call the Fire Department Emergency Battalion at 206.795.3350
- Alert Fire Department of the situation
- Provide area to be called, N 171st and N 172nd on both sides of the street from Meridian Avenue N east to I-5

Hot Spot Check for the Early Warning System

- The Early Warning System has two components to check during the hotspot inspection: Water level calibration and verifying the website is updating current data.
- The water level should be checked and calibrated if necessary. The water level is checked on the staff gauge adjacent to the bog outlet. This level is compared to the monitor readings. If the observed level differs from the monitor readings, the monitor must have its offset changed to reflect its elevation. To alter the offset, open the monitor > Press Menu > Real Time Data > Public > scroll down to offset hit ENTER and reset the offset so that the bog level = 361.75 + staff reading.
- Staff verifies the website is updating with the current water level readings. If the water level needs to be adjusted on the monitor based on staff gauge observations, the website should be re-checked to confirm data is continuing to update. Below is the website address to check water levels: <http://cityofshoreline.com/government/departments/public-works/surface-water-utility/ronald-bog-early-warning>

Below are instruction to remotely connect to the monitor to make changes to the water level or collect the most recent data.

Connecting to the Ronald Bog Monitor

The monitor is set to automatically gather data, but if you choose to connect first hit the button on the task bar.



5.7 Severe Weather Response

Large natural events (precipitation and wind) that result in flooding or power outages must be managed in a predictable and scalable manner with known responsibilities and means of escalation to include additional City response staff.

5.7.1 Preparation

All severe weather response actions will be performed in accordance with the Shoreline Comprehensive Emergency Management Plan (CEMP) and incident command protocols. Surface Water Utility will conduct severe weather preparations when severe weather is forecasted by the

National Weather Service or WeatherNet which may impact public stormwater infrastructure or pose a threat to property, life, or the environment.

- Initial severe weather preparations include:
 - Surface Water and Environmental Services (SWES) staff continuously monitoring WeatherNet and National Weather Service for forecast and severe weather-related warnings
 - Perform hotspot inspections prior to storm event
 - Ensure staff coverage prior to when storm begins
 - Ensure response vehicles are equipped with necessary tools and materials to carry out severe weather response tasks
 - Ensure 800 MHz radios are fully charged and ready for staff deployment
- Severe weather response thresholds include:
 - If three storm-related service requests are received by the City within a 30-minute interval
 - National Weather Service storm-related warnings are occurring or imminent
 - Storm-related weather is threatening the function of public stormwater infrastructure or creating a hazardous condition which is affecting private property, safety, or the environment

5.7.2 Response

This section summarizes the office and field response plans in an event of a severe storm.

Office. One SWES Staff will take positions with the Customer Response Team (CRT) and act as dispatcher while assisting the CRT admin with call intake as necessary. The dispatcher will:

- Coordinate and prioritize service request calls and internal operations.
- Communicate using an 800-megahertz (MHz) radio.
- Section the city into quadrants, but may dispatch staff as needed within those sections.
- Keep the program manager informed of event developments.

Field. Field-related responses include:

- Utility staff will immediately begin checking hot spots and respond to public infrastructure-related service calls as necessary.
- Streets staff will survey ROW public infrastructure, clearing arterial roadways of any ponding or storm-related issues. Staff will also assist with CRT as needed (e.g., deliver pumps, sandbags, etc.).
- CRT staff will respond to customer-related calls. If additional staff or materials (e.g., pumps) are required, Streets Department staff may assist or replace CRT staff at the behest of the dispatcher or incident commander.

Escalation. The storm response will escalate if:

- City Hall suffers a power outage
- If it appears that public safety is threatened or significant property damage is likely
- If call takers are unable to attend all calls as they come in
- Storm-related calls are outstripping field staff availability and assistance beyond that of SWES, Roads Department, and CRT combined, or all available staff
- The forecast predicts the storm to last longer than 12 hours after SWES has begun its storm response

- Complicating factors such as wind, earthquakes, landslides, snow, etc. occur or are predicted to occur within 12 hours of SWES storm response

Prioritization. The City will prioritize service calls by priority level:

- Life and safety threats within the ROW or on City property:
 - Threats to publicly owned infrastructure
 - Private property flooding from a publicly owned source (e.g., water off roadway)
 - Clearing of water across arterial roadways
 - Life and safety threats outside the ROW or City property
 - Potential non-life threatening public property/infrastructure/environmental damage
 - Potential non-life threatening private property flooding/environmental damage from a City-owned source (e.g., roadway drainage to house or private street)
 - Potential non-life threatening private property flooding/environmental damage from a non-City-owned source (e.g., house to house or private street)

5.8 Spill Response

It is the City's obligation under the NPDES Phase II permit to provide spill prevention, spill response planning and training, and spill cleanup. The City therefore has a City-wide Spill Response Plan as well as a municipal stormwater pollution prevention plan (SWPPP) for both the Hamlin Maintenance Yard and the North Maintenance Facility. These plans describe the methods and procedures that City personnel will implement to reduce or eliminate the contamination of stormwater runoff or discharges of pollutants from City operations at the facilities and in the field.

Spills can be identified by various means. A City employee may encounter a spill or identify an illicit discharge while in the field. A citizen may encounter a spill and contact the City's Customer Response Team. All City employees must follow the City's Spill Response Plan (Appendix P), located on the City's website at <http://www.cityofshoreline.com/government/departments/public-works/surface-water-utility/water-quality/spill-response-program>.

5.9 Vegetation Control

The Utility uses a variety of tools to manage vegetation within stormwater assets. Given the variety of assets within the city, a host of service levels are employed.

- **Stormwater Facilities.** Control requires at least annual vegetation maintenance, using goats at larger sites and contractors for high LOS vegetation control.
- **Ditch.** Vegetation is controlled as needed for ditch function or as needed in preparation of maintenance. Ditch vegetation may provide water quality benefits and may not be controlled solely for aesthetic purposes.
- **Trees.** Trees within the ROW are not managed by the Utility. Within stormwater facilities, trees are maintained as needed to mitigate risks to life, public safety, and public infrastructure.

5.10 Vegetation Management

There are several types of invasive plants within the city, described below.

- **Invasive Plants/Noxious Weeds.** There are variety of non-native plants growing within the city ROW and public property. Of those non-native plant species, there are many that are invasive, but few that are classified as noxious. The City references the King County Noxious Weed Control Board and the Washington State noxious weed control law (17.10 Revised Code of Washington [RCW]). The state classifies noxious weeds into three categories: A, B, and C.
- **Class A Weeds.** Class A weeds are mostly newcomers to Washington, and are generally rare. The goal is to completely eradicate them before they gain a foothold. Landowners are required to completely eradicate Class A weeds.
- **Class B Weeds.** Class B weeds are those that are widespread in some parts of the state, but rare or absent in other parts of the state. The goal with Class B weeds is to prevent them from spreading into new areas, and to contain or reduce their population in already infested areas.
- **Class C Weeds.** Class C weeds are typically common and widespread. Rather than requiring control of these plants, most county weed boards simply offer advice to landowners about the most effective control methods. A county weed board may require landowners to control a Class C weed if it poses a threat to agriculture or natural resources.

Invasive plants are generally not acceptable within the City ROW and public property. Invasive plants should be controlled in conjunction with natural resource enhancement efforts, particularly within natural and sensitive areas.

Noxious weeds are generally not acceptable within the City ROW and public property, and should be controlled in conformance with State of Washington requirements for noxious weeds. In the event of a noxious weed being identified or brought to the attention of the City, staff should review current designation and control requirements.

The primary noxious weeds within the ROW and public property are shown in Table 5-4. These noxious weeds are primarily controlled to the point of not interfering with operations. None of the plants listed are regulated and are not required to be controlled or removed.

Table 5-4. Noxious Weeds in ROW and on Private Property		
Common Name	Binomial Nomenclature	Control Method
English Ivy	<i>Hedera helix</i>	Physical removal and herbicide application
Japanese knotweed	<i>Fallopia japonica</i>	Herbicide application via injection and spraying
Reed canary grass	<i>Phalaris arundinacea</i>	Physical removal, smothering, and herbicide application
Scotch broom	<i>Cytisus scoparius</i>	Physical removal

Section 6

References

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Appendix A: Cityworks Service Requests Guide (2015 User Guide - Service Request Basics.docx)

Appendix A

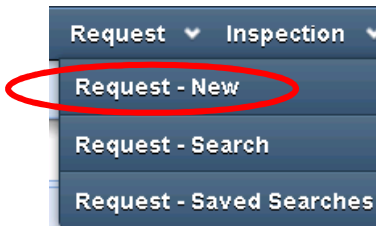
City Works Service Request Guide

Service requests are used to track complaints/requests for services that come in from citizens, contractors, or other employees. Requests consist of a problem code, incident location, caller information, response information, and related work activities. Service request could originate from a customer calling in with a complaint, a submittal from a public web portal, or many other ways.

Section 1 Service Requests

1.1 Creating a New Service Request

1. First, ensure the map panel is open.
2. Navigate to the New Service Request screen by selecting the arrow next to the Request tab, and then click on **Request - New**.



3. The first step in creating a service request is identifying the problem type. There are two ways to identify the problem type - **Problem Keyword** and **Problem Tree**. To select one of these methods, click on the pertinent tab at the top of the New Service Request Screen.



4. The first method is through the **Problem Keyword**. Type in a word and press enter or click on the Find button to search for any problem types that match this keyword.

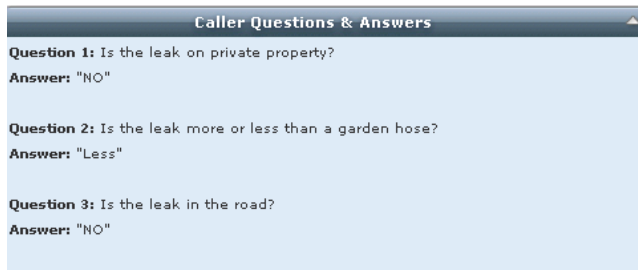
5. Any problem type that matches the keyword entered will appear in the panel. To create a service request with one of the problem types, click on the problem code.

Problem Code	Description
TREES/VEGETATION	Trees / Vegetation Issues
VEGET	Vegetation

6. The second method for request type searches is through the **Problem Tree**. The left pane of the tree shows problem types grouped roughly by department, and the right pane shows problems.

7. After the problem type has been identified, more information needs to be collected for the request. The next step in creating the request is answering predefined questions to gather more information on the request. In the **Create New Service Request** screen, scroll down to the **Caller Questions & Answers** panel and answer the questions in the Answer field clicking **Next** until there are no more answers.

8. This helps provide valuable information for internal staff. Not all service requests will have questions and answers - this is an optional item.



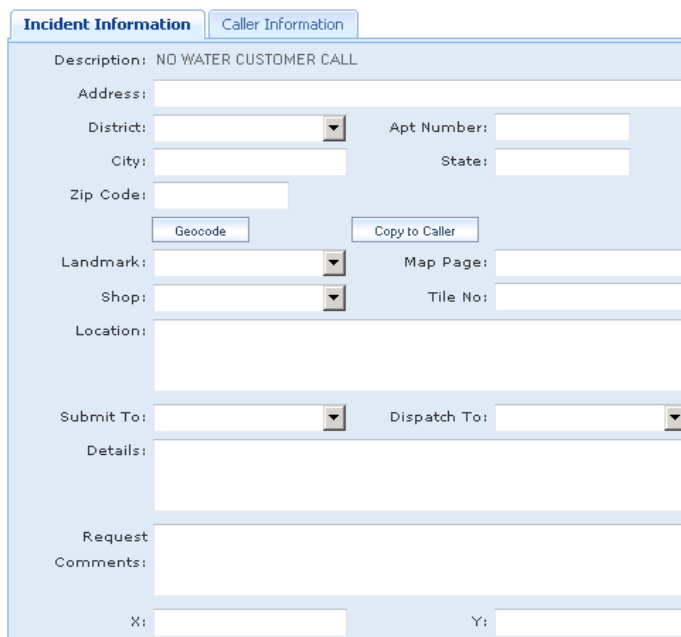
Caller Questions & Answers

Question 1: Is the leak on private property?
Answer: "NO"

Question 2: Is the leak more or less than a garden hose?
Answer: "Less"

Question 3: Is the leak in the road?
Answer: "NO"

9. Once the questions and answers are completed, complete the fields in the Incident Information Tab.



Incident Information | Caller Information

Description: NO WATER CUSTOMER CALL

Address:

District: Apt Number:

City: State:

Zip Code:

Landmark: Map Page:

Shop: Tile No:

Location:

Submit To: Dispatch To:

Details:

Request:

Comments:

X: Y:

10. When entering the address, type the street number, and then the first three letters of the street name (without directional notation). Once the first three letters are entered a list of possible street names will appear. Pick the street name that best matches. If none match, manually enter the address.

The screenshot shows the 'Incident Information' tab of a service request form. The 'Address' field contains '108 aur'. Below it, a dropdown menu is open, displaying '108 AURORA AVE N SHORELINE 98133' as a suggestion. Other fields include 'District', 'City', 'Zip Code', 'Geocode', 'Copy to Caller', 'Landmark', 'Map Page', 'Shop', and 'Tile No'.

11. Once the address is entered, press the Geocode button to locate the address on the map.

This screenshot shows the 'Incident Information' tab with the address '108 AURORA AVE N' entered. The 'Geocode' button is circled in red. Other fields include 'Neighborhood', 'Apt Number', 'City' (SHORELINE), 'State', 'Zip Code' (98133), 'Landmark', 'Maint Zone', 'Shop', and 'Basin'.

12. Once the location of the services request has been found, enter the caller's information in the **Caller Information** tab.
If the caller address and incident address are the same, click the **Copy to Caller** button on the **Incident Information** tab to copy this information.
13. Once all the information is entered, check the **Existing Requests with the Same Problem Code** panel on the **Caller Information** tab. This provides the ability to add the new caller to an existing service request if the caller is calling in about a problem that already has a service request created for it. If the new caller can be added to an existing request, highlight the records and click **Save**.

NOTE: this search is limited to the area shown on the map, so make sure you have the map open and showing the area around the address of the problem.

Existing Requests with the Same Problem Code

Search To add caller to existing request, highlight record and save.

Id	Address	Priority	Date Initiated	Field Invt D
4401	1666 E PEBBLE CREEK BLVD	2	6/26/2004 8:43:00 AM	False

14. To create the request click on the Save button.



15. Once the request is saved, the Request ID is populated. This ID will never change and will only be used one time within the system.

1.2 Updating a Service Request

NOTE: Service Requests should be handled within 24 working hours and status changed either to Assigned, Completed, or On Hold.

1. Open a service request record.
2. Update all necessary information in the **Service Request** panel.

The screenshot shows the 'Service Request' form. It includes fields for Description (NO WATER CUSTOMER CALL), Request Id (21), Category, Priority (Emergency), Status (Assigned), Initiated By (TESTING1, TEST1), Date (6/15/2012 10:25 AM), Investigation, Date, Emergency, WO Needed, Submit To, Date, Dispatch To, Date, Project Name, Pj. Comp. Date, Project Tree, Cancel?, Date, Cancel Reason, Cancelled By, Closed By, Date, New Comments, Select, Existing Comments, and a scroll bar.

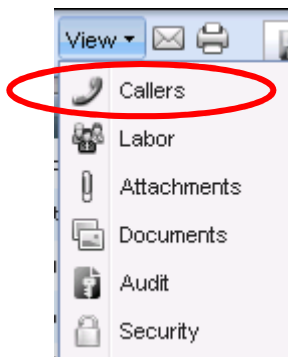
3. Update any information that needs to be updated in the Incident Information panel.

The screenshot shows the 'Incident Information' form. It includes fields for Address (620 E WINDSOR RD), Apt #, City (GLENDALE), State (CA), Zip Code (91205), Landmark, Shop, Tile No, Map Page, District, Location, Details, X (6,482,923.92), and Y (1,886,415.41).

4. Once all updates are made, click the **Save** button.

1.3 Add Additional Callers

1. To add additional callers click **View** dropdown menu and then select the **Callers** button.



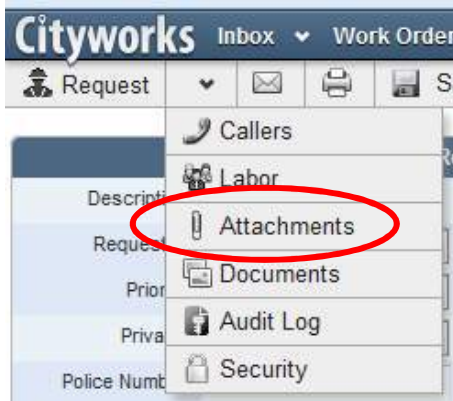
2. The toolbar will change once the user selects the Callers option above. The option to select **New Caller** becomes available.



3. When the user selects **New Caller**, the caller information panel becomes available as described under Caller Information, located on in the Create New Request section.
4. After the new caller information has been populated, click on the **Save** button to successfully add the caller to the request.
5. If a caller was mistakenly added, the **Delete** button can be used to the delete the caller by highlighting the caller and clicking on the delete button.

1.4 Adding Attachments to the Service Request

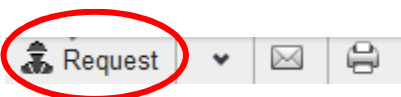
1. The availability of adding attachments is listed under the **View** dropdown. Click on **Attachments** in the View dropdown to open the attachments page.



2. Click on the **Browse** button.
3. Search for the document(s) the need to be added to the request.
4. Add comments to identify what the attachment is.
5. Click the **Upload** button.



6. To return back to the request screen, click on the **Request** button in the request menu.

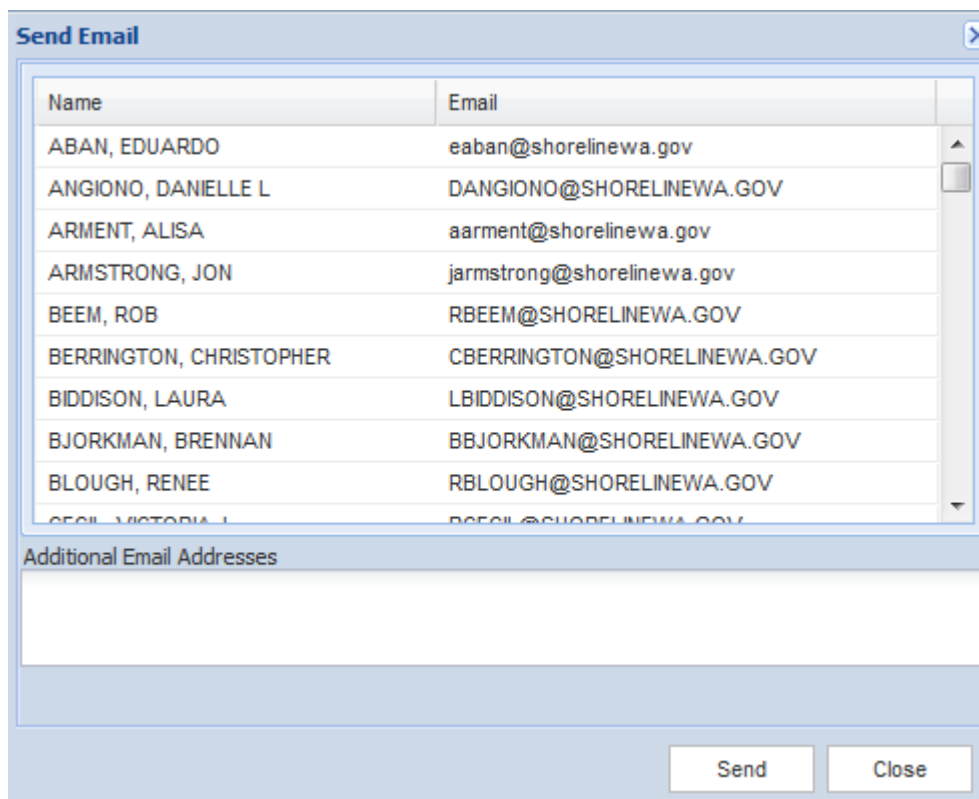


1.5 Manually Email a Service Request

1. To manually email a service request, click on the envelope button in the service request toolbar.



2. Select one or more of the employees from the list to email and click on the **Send** button.
3. Alternatively, if an outside email is required, type the email in the **Additional Email Addresses** field and click **Send**.

A screenshot of a 'Send Email' dialog box. It features a table with two columns: 'Name' and 'Email'. The table lists several employees with their names and email addresses. Below the table is a text area labeled 'Additional Email Addresses'. At the bottom right, there are 'Send' and 'Close' buttons.

Name	Email
ABAN, EDUARDO	eaban@shorelinewa.gov
ANGIONO, DANIELLE L	DANGIONO@SHORELINEWA.GOV
ARMENT, ALISA	aarment@shorelinewa.gov
ARMSTRONG, JON	jarmstrong@shorelinewa.gov
BEEM, ROB	RBEEM@SHORELINEWA.GOV
BERRINGTON, CHRISTOPHER	CBERRINGTON@SHORELINEWA.GOV
BIDDISON, LAURA	LBIDDISON@SHORELINEWA.GOV
BJORKMAN, BRENNAN	BBJORKMAN@SHORELINEWA.GOV
BLOUGH, RENEE	RBLOUGH@SHORELINEWA.GOV
BECIL, VICTORIA L	RBECIL@SHORELINEWA.GOV

1.6 Create a Work Order from the Service Request

1. If a work order needs to be created to complete the request, the work order should be created from the request screen so that the request and work order are linked together.
2. Before creating the work order, select an asset from the map that the work order will be created against.
3. With the asset selected through the map or GIS Search, click the **Create Work Order** button from the service request's **Related Work Activities** panel.

Work Orders

Add:

Group assets? ☒

4. Follow the steps from the *Work Order and Inspection Guide* to finish creating the work order.
5. If a work order has already been created, but was not properly attached to the service request, it can be attached. In the request's Related Work Activities panel, enter the work order id in the **Add** field.

Work Orders

Add:

Group assets? ☒

6. Click on the Save button from the main service request menu.



7. Once the request is saved, the work order will be attached to the request.

Work Orders

Add:

Group assets? ☒


<input type="checkbox"/>	Id	Description	Priority	Status	Submit To	Proj Start Da
<input checked="" type="checkbox"/>	561	MECHANICAL RESHAPE	5	CLOSED	GILMORE, ERIC	9/3/2013 10:

NOTE: When a work order is attached to a service request, the request will be closed when the work order is closed.

1.7 Updating Multiple Records

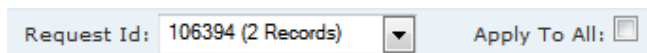
Some scenarios require that multiple requests be updated with the same information. It is more convenient to perform this action with a batch update.

1. Perform a search and select multiple records that need to be updated by placing a check box next to the Request ID. If you can't figure out how to search, instructions are below.
2. Use the Open Selected button to open the selected requests into the same form.

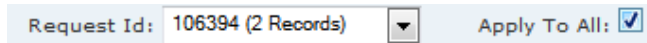


Drag a column header and drop it here to group by that column			
	RequestId	Date Initiated	Description
<input type="checkbox"/>	36	4/8/2013 8:26 AM	ABANDONED MATERIAL
<input checked="" type="checkbox"/>	37	4/8/2013 8:48 AM	DRAINAGE CREEKS OTHER
<input checked="" type="checkbox"/>	38	4/8/2013 9:37 AM	POTHoles
<input type="checkbox"/>	39	4/8/2013 9:39 AM	POTHoles
<input type="checkbox"/>	40	4/8/2013 9:47 AM	DISPLACEMENT

3. In the request screen, the Request ID field should identify how many records are open. Additionally, an Apply To All checkbox displays.



4. To update all selected records at once, check the Apply To All checkbox.



5. Update the fields that need to be updated, and click the **Save** button.

NOTE: Requests cannot be closed in a batch mode.

1.8 Closing a Service Request

Requests that do not require a work order will need to be closed once there is a resolution. Closing the service request completes the requests and no more changes can be made. Follow these steps to close a service request.

1. In the request, ensure that all required fields are completed. Fields that are required are highlighted pink with red text.
2. Add any final comments, and click the Close button to close the service request.

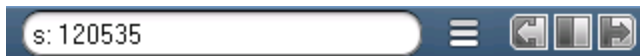


Section 2 Searching Service Requests

Within a service request, information is gathered and recorded within the main database. Therefore, the information that is captured within the request may be searched for a later time.

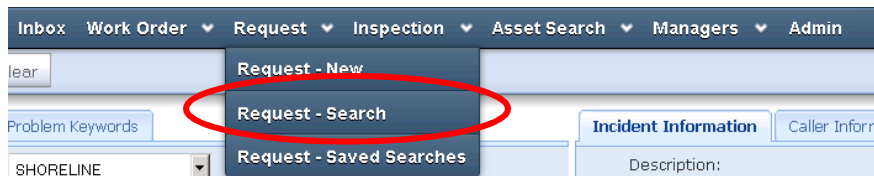
2.1 Quick Search Tool

If you know the Service Request ID you are searching for, in the top right of the screen there is a search tool. Type the following as an example SR:21 (e.g. 's', 'r', or 'sr' for service requests) and hit the enter button. This will locate the service request quickly without having to open the service request search screen.



2.2 Service Request Search

1. To navigate to the request search screen, click the dropdown arrow next to the **Service Request** tab and click on **Search Requests**.



2. Before beginning any search, clear the screen by clicking on the **Clear** button on the toolbar.



3. The General Tab includes items that are directly related to the service request. If the **Request ID** is known, type the number into the **Request ID** field. Enter at least one search parameter and click the **Search** button to initiate a search and list the results.

4. Use dropdowns to select pick list items like Submit To, Category, and Status.

The screenshot shows the 'General' tab of a service request form. The form includes the following fields:

- Request ID(s):
- Domain: (dropdown)
- Initiated By: (dropdown with calendar icon)
- Submitted To: (dropdown with calendar icon)
- Submit Opened: (dropdown with calendar icon)
- Dispatched To: (dropdown with calendar icon)
- Dispatch Open: (dropdown with calendar icon)
- Closed By: (dropdown with calendar icon)
- Prj. Comp. Date: (dropdown with calendar icon)
- Details: (text area)
- Comments: (text area)
- Priority: (dropdown)
- Status: (dropdown)
- Past Due: (dropdown)
- Resolution: (dropdown)
- Completed?: (dropdown with calendar icon)
- Emergency?: (dropdown)
- Closed?: (dropdown)
- WO Needed?: (dropdown)
- Work Order ID: (text input)
- Has Work Order: (dropdown)
- Has Inspection: (dropdown)
- Cancelled?: (dropdown with calendar icon)
- Project: (dropdown)
- Category: (dropdown)
- Map Page: (text input)
- Shop: (dropdown)
- Tile No.: (text input)
- X Min: (text input)
- X Max: (text input)
- Y Min: (text input)
- Y Max: (text input)

5. On the General tab, enter From/To dates by checking the checkbox as shown below. Once the box has been checked the options are presented to either select a start and finish date range using the calendar or by selecting the option for Last and the user can fill in the number, then select Hours, Days, Weeks or Months.

The screenshot shows the 'General' tab with the date selection interface. The 'Submit Opened' field has a checkbox checked, which has triggered a date range selector. The selector includes:


- Start and Finish date inputs with calendar icons.
- A 'Last' dropdown menu.
- A 'Day(s)' dropdown menu.
- An 'Apply' button.

6. The Details tab consists of the Incident information, Caller and the Other System Information grids.

a. Incident information:

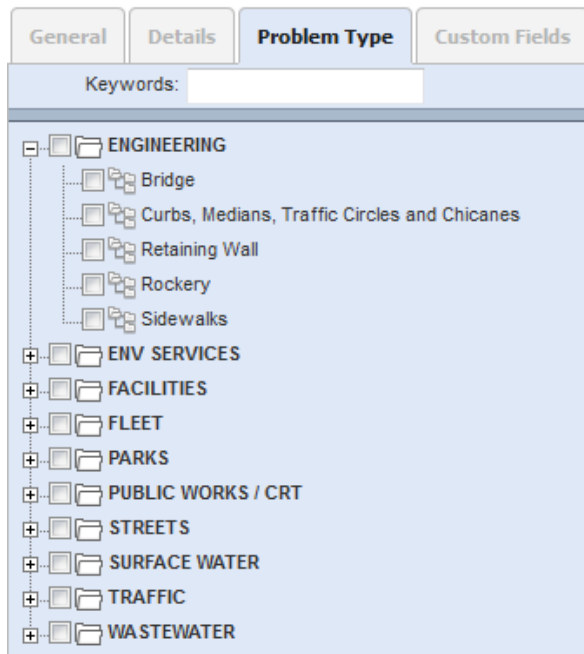
General	Details	Problem Type	Custom Fields
Incident			
Address Type: <input type="text"/>			
Address: <input type="text"/>			
Apt Number: <input type="text"/>			
City: <input type="text"/>		State: <input type="text"/>	
Zip Code: <input type="text"/>		Street Name: <input type="text"/>	
Location Details: <input type="text"/>			
Problem Details: <input type="text"/>			
X Location: <input type="text"/>		Y Location: <input type="text"/>	

b. Caller information:

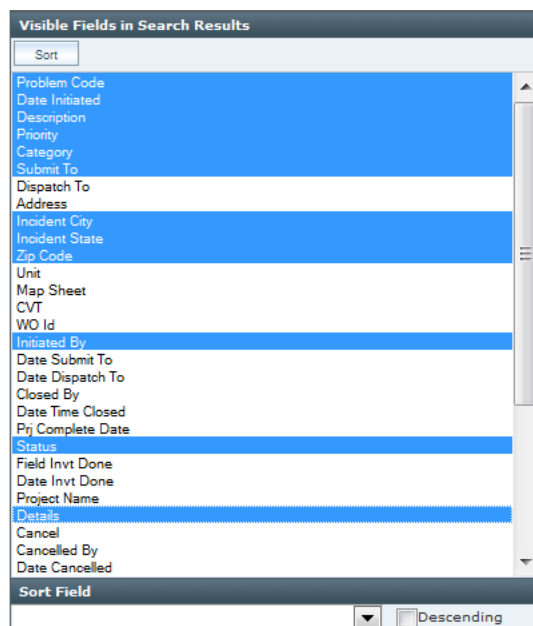
Caller	
Call Date: <input type="text"/>	
Account: <input type="text"/>	Caller Type: <input type="text"/>
Name(F,M,L): <input type="text"/>	<input type="text"/>
Caller Address: <input type="text"/>	
Apt. Number: <input type="text"/>	
Cust. City: <input type="text"/>	Cust. State: <input type="text"/>
Cust. Zip Code: <input type="text"/>	
Day Phone: <input type="text"/>	Other Phone: <input type="text"/>
Cell Phone: <input type="text"/>	Fax: <input type="text"/>
Email: <input type="text"/>	
Caller Comments: <input type="text"/>	
Is Resident?: <input type="text"/>	Follow-Up Call?: <input type="text"/>
Call Back?: <input type="text"/>	Cust. Contact?: <input type="text"/>

NOTE: Fields in these panels can be searched on by entering text values into them. Wild card searches can be performed by using the % symbol. For example, in one of the address fields, the name of the street could be entered between wild cards (%Main%) and all requests on that street would be returned.

7. A user can select the Problem Type tab whereby the checkbox shown next to the folder, sub-folder and/or service request type. If a high-level folder or sub-folder is chosen then the items listed under that folder will all be selected as well. See the example below.



8. In order to update the results list that is presented after the user enters the search criteria and clicks on the search button, the user must highlight the fields they wish to show in the search. Click on each field and use the control button to select more fields to show in the results list.



9. Once all the parameters are set for the search, click the **Search** button to perform the search.

2.3 Search Results

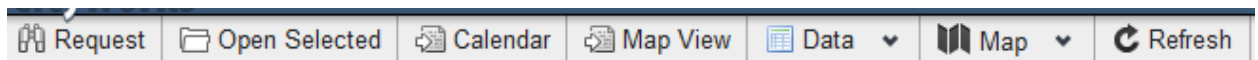
1. Once the search is run, the results of the search are displayed in the search results screen. Data can be sorted by clicking field headers. To open a record, click on the Request ID link in the results list.

<input type="checkbox"/>	RequestId	Date Initiated	Description	Priority
<input type="checkbox"/>	8	3/18/2013 11:18 AM	BEEES	3
<input type="checkbox"/>	9	3/18/2013 12:52 PM	POTHOLES	3
<input type="checkbox"/>	10	3/18/2013 1:26 PM	DEAD ANIMAL	3
<input type="checkbox"/>	11	3/18/2013 1:27 PM	PARK GRAFFITI	3

2. Grouping can be performed in the search results screen by dragging a field header to the gray area above the field headers.

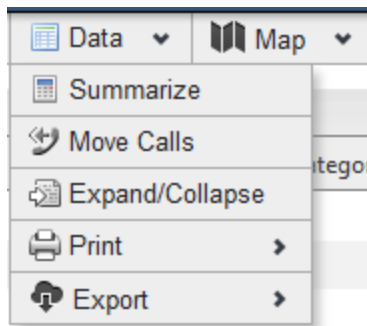
Drag a column header and drop it here to group by that column				
<input type="checkbox"/>	RequestId	Date Initiated		
<input type="checkbox"/>	8	3/18/2013 11:18 AM		
<input type="checkbox"/>	9	3/18/2013 12:52 PM		

3. To ungroup, drag the grouped header back down to the row of field headings.
4. The result list screen is presented with the following search tools:

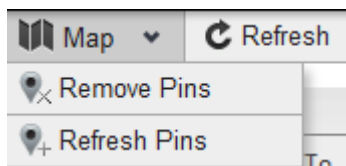


- **Request** - This button will bring the user back to the search criteria screen to either make modifications or to clear the screen and select a new search criteria.
- **Open Selected** - Within the results list screen, a user can select service requests by highlighting the requests they would like to review (use the control button to select more than one record at a time). Clicking the **Open Selected** button will open all selected records. This can be used to update more than one record at a time.
- **Calendar** - Displays the search results list within a Calendar view. This information is more clearly defined in the section called Calendar.
- **Map View** - Views the results in a map view.

- **Data** - Dropdown menu that provides users with numerous methods to view data (i.e. printing or exporting).



- **Map** - Dropdown list that allows users to remove or refresh pins shown in the search results.



NOTE: The map must be open in order for the user to utilize this function.

- **Refresh Button** - Refreshes the search results.

2.4 Search Results - Calendar

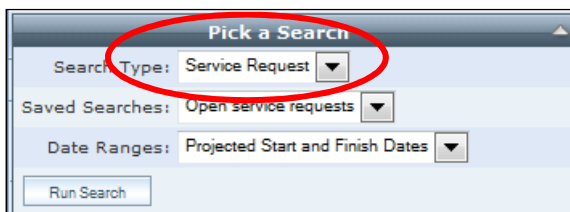
1. The Calendar button takes the results list grid format and populates a calendar to view the search criteria.
2. Request records can be “rescheduled” by dragging and dropping records to a new day.



3. If the search criteria originally used needs to be modified, or the user would like to see another search in the calendar view, they can click on **Change Search** from the toolbar.

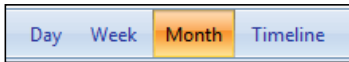


4. The **Pick a Search** pop up box is displayed. These menus configure what is displayed on the calendar:



- **Search Type** - Select from Service Requests, Workorders or Inspections.
- **Saved Searches** - Saved searches for the selected search type.
- **Date Ranges** - Configure whether projected start and finish dates or actual start and finish dates.

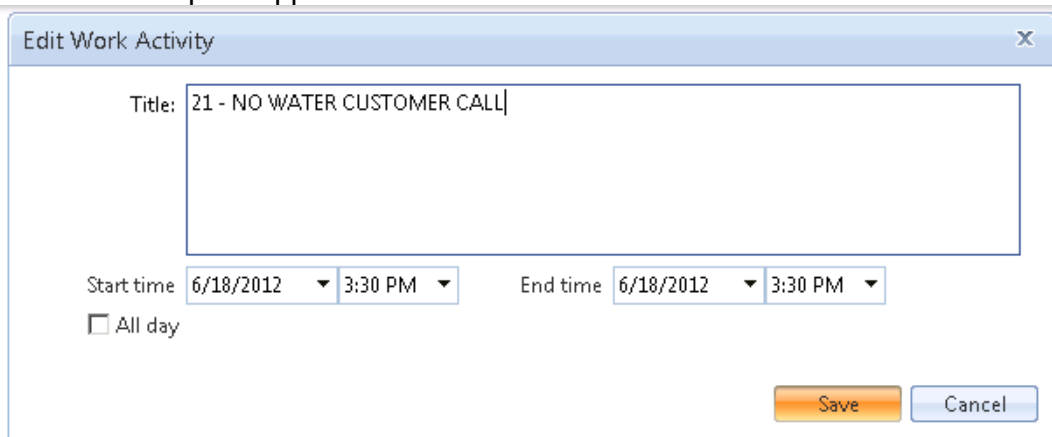
5. After the information from the Pick a Search box is updated, click on the **Run Search** button and the new criteria is added to the calendar.
6. Located on the right-hand side of the calendar is the option to see the calendar display in Day, Week, Month or in a Timeline. Just click on the type of display preferred and the calendar will modify its display.



7. Located on the left-hand side of the calendar is the option to move months with the arrow keys



8. The today link will move the calendar to the day range the current day falls within. The dropdown calendar button next to the today link is used to select a date to move the calendar to the date range that dates falls within.
9. Service requests can be opened from the calendar by double clicking on the request and the Edit Work Activity screen is displayed. Date ranges can be updated to move the service request appointment.

A dialog box titled 'Edit Work Activity' with a close button (X) in the top right corner. It contains a 'Title' field with the text '21 - NO WATER CUSTOMER CALL'. Below the title field are two date and time pickers. The 'Start time' picker shows '6/18/2012' and '3:30 PM'. The 'End time' picker shows '6/18/2012' and '3:30 PM'. There is an 'All day' checkbox which is currently unchecked. At the bottom right are 'Save' and 'Cancel' buttons.

Edit Work Activity

Title: 21 - NO WATER CUSTOMER CALL

Start time 6/18/2012 3:30 PM End time 6/18/2012 3:30 PM

☐ All day

Save Cancel

2.5 Saving Searches

- When a search is used often, search criteria from the Request Search screen can be saved to be run at a later time or added to a user's Inbox. The search toolbar consists of the Search, Clear, Open and Save As buttons as shown below.



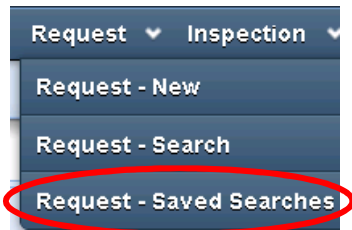
- In the following example, search parameters have been setup to search for open service requests. To save the search, click the **Save As** button.

- In the Save As screen, provide the search a Name and Description. Select the radio button for the search to be available to all in the Domain, all in the same Group, or Self. Click the **Save** button to save the search.

NOTE: Only Administrators should save searches to the Domain.

2.6 Opening Saved Searches

1. Using the Request menu, click on Request- Saved Searches.



2. A list of saved searches will appear.

Select Search									
<input type="button" value="View In Grid"/>		<input type="button" value="Delete Selected"/>							
<input type="checkbox"/>	Name	Description	Date Created	Created By	Shared By	Edit	Type	Map	Service
<input type="checkbox"/>	WWC Service Requests Open		4/1/2013 8:49 AM	NANCE, RALPH E	Group	Edit	Request	Map	Service
<input type="checkbox"/>	WD ALL OPEN SERVICE ORDERS		4/1/2013 8:00 AM	EVANS, NOAH M	Group	Edit	Request	Map	Service

3. Select the search to open from the list and click on the **View in Grid** button. Searches can be updated before performing the search by selecting the edit button on the far right. The user can also delete the selected saved search if it is no longer needed.

NOTE: If the Shared By column displays “Domain” or “Group”, DO NOT delete the search. Consult the person listed under “Created By” before deleting anything.

4. The search results list is now shown.

Drag a column header and drop it here to group by that column			
<input type="checkbox"/>	RequestId	Date Initiated	Description
<input type="checkbox"/>	24	3/25/2013 1:18 PM	SERVICE LEAKS
<input type="checkbox"/>	25	3/25/2013 1:19 PM	SERVICE LEAKS
<input type="checkbox"/>	26	3/25/2013 2:07 PM	WATER METER LEAKS
<input type="checkbox"/>	50	4/17/2013 2:41 PM	WATER MAIN LEAKS
<input type="checkbox"/>	67	5/15/2013 2:39 PM	WATER MAIN LEAKS
<input type="checkbox"/>	73	5/21/2013 8:26 AM	TURN ON/OFFS (Springbrook)
<input type="checkbox"/>	74	5/21/2013 8:30 AM	HYDRANT KNOCKDOWN

Appendix B: 2014 SWMMWW Tables

Highlighted items in SWMMWW Table of Contents
are assets included in O&M Manual

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V-4.6 Maintenance Standards for Drainage Facilities

The facility-specific maintenance standards contained in this section are intended to be conditions for determining if maintenance actions are required as identified through inspection. They are not intended to be measures of the facility's required condition at all times between inspections. In other words, exceedence of these conditions at any time between inspections and/or maintenance does not automatically constitute a violation of these standards. However, based upon inspection observations, the inspection and maintenance schedules shall be adjusted to minimize the length of time that a facility is in a condition that requires a maintenance action.

Table V-4.5.2(1) Maintenance Standards - Detention Ponds

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash & Debris	Any trash and debris which exceed 1 cubic feet per 1,000 square feet. In general, there should be no visual evidence of dumping. If less than threshold all trash and debris will be removed as part of next scheduled maintenance.	Trash and debris cleared from site
	Poisonous Vegetation and noxious weeds	Any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined by State or local regulations. (Apply requirements of adopted IPM policies for the use of herbicides).	No danger of poisonous vegetation where maintenance personnel or the public might normally be. (Coordinate with local health department) Complete eradication of noxious weeds may not be possible. Compliance with State or local eradication policies required
	Contaminants	Any evidence of oil,	No contaminants or pol-

Table V-4.5.2(1) Maintenance Standards - Detention Ponds (continued)

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
	and Pollution	gasoline, contaminants or other pollutants (Coordinate removal/cleanup with local water quality response agency).	lutants present.
	Rodent Holes	Any evidence of rodent holes if facility is acting as a dam or berm, or any evidence of water piping through dam or berm via rodent holes.	Rodents destroyed and dam or berm repaired. (Coordinate with local health department; coordinate with Ecology Dam Safety Office if pond exceeds 10 acre-feet.)
	Beaver Dams	Dam results in change or function of the facility.	Facility is returned to design function. (Coordinate trapping of beavers and removal of dams with appropriate permitting agencies)
	Insects	When insects such as wasps and hornets interfere with maintenance activities.	Insects destroyed or removed from site. Apply insecticides in compliance with adopted IPM policies
	Tree Growth and Hazard Trees	Tree growth does not allow maintenance access or interferes with maintenance activity (i.e., slope mowing, silt removal, vactoring, or equipment movements). If trees are not interfering with access or maintenance, do not remove	Trees do not hinder maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (e.g., alders for firewood). Remove hazard Trees

Table V-4.5.2(1) Maintenance Standards - Detention Ponds (continued)

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
		If dead, diseased, or dying trees are identified (Use a certified Arborist to determine health of tree or removal requirements)	
Side Slopes of Pond	Erosion	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion. Any erosion observed on a compacted berm embankment.	Slopes should be stabilized using appropriate erosion control measure (s); e.g., rock reinforcement, planting of grass, compaction. If erosion is occurring on compacted berms a licensed civil engineer should be consulted to resolve source of erosion.
Storage Area	Sediment	Accumulated sediment that exceeds 10% of the designed pond depth unless otherwise specified or affects inletting or outletting condition of the facility.	Sediment cleaned out to designed pond shape and depth; pond reseeded if necessary to control erosion.
	Liner (if Applicable)	Liner is visible and has more than three 1/4-inch holes in it.	Liner repaired or replaced. Liner is fully covered.
Ponds Berms (Dikes)	Settlements	Any part of berm which has settled 4 inches lower than the design elevation If settlement is apparent, measure berm to determine amount of settlement	Dike is built back to the design elevation.

Table V-4.5.2(1) Maintenance Standards - Detention Ponds (continued)

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
		Settling can be an indication of more severe problems with the berm or outlet works. A licensed civil engineer should be consulted to determine the source of the settlement.	
	Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Geotechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.
Emergency Overflow/ Spillway and Berms over 4 feet in height	Tree Growth	Tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping. Tree growth on berms over 4 feet in height may lead to piping through the berm which could lead to failure of the berm.	Trees should be removed. If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A licensed civil engineer should be consulted for proper berm/spillway restoration.
	Piping	Discernable water flow through pond berm. Ongoing erosion with	Piping eliminated. Erosion potential resolved.

Table V-4.5.2(1) Maintenance Standards - Detention Ponds (continued)

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
		potential for erosion to continue. (Recommend a Geotechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	
Emergency Overflow/Spillway	Emergency Overflow/Spillway	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil at the top of out flow path of spillway. (Rip-rap on inside slopes need not be replaced.)	Rocks and pad depth are restored to design standards.
	Erosion	See "Side Slopes of Pond"	

Table V-4.5.2(2) Maintenance Standards - Infiltration

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash & Debris	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Poisonous/Noxious Vegetation	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Contaminants and Pollution	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Rodent Holes	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
Storage Area	Sediment	Water ponding in infiltration pond after rainfall ceases and appropriate	Sediment is removed

Table V-4.5.2(2) Maintenance Standards - Infiltration (continued)

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
		time allowed for infiltration. Treatment basins should infiltrate Water Quality Design Storm Volume within 48 hours, and empty within 24 hours after cessation of most rain events. (A percolation test pit or test of facility indicates facility is only working at 90% of its designed capabilities. Test every 2 to 5 years. If two inches or more sediment is present, remove).	and/or facility is cleaned so that infiltration system works according to design.
Filter Bags (if applicable)	Filled with Sediment and Debris	Sediment and debris fill bag more than 1/2 full.	Filter bag is replaced or system is redesigned.
Rock Filters	Sediment and Debris	By visual inspection, little or no water flows through filter during heavy rain storms.	Gravel in rock filter is replaced.
Side Slopes of Pond	Erosion	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
Emergency Overflow Spillway and Berms over 4 feet in height.	Tree Growth	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Piping	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
Emergency Overflow Spillway	Rock Missing	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Erosion	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
Pre-settling Ponds and Vaults	Facility or sump filled with Sediment and/or debris	6" or designed sediment trap depth of sediment.	Sediment is removed.

**Table V-4.5.2(3) Maintenance Standards - Closed Detention Systems
(Tanks/Vaults)**

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Storage Area	Plugged Air Vents	One-half of the cross section of a vent is blocked at any point or the vent is damaged.	Vents open and functioning.
	Debris and Sediment	Accumulated sediment depth exceeds 10% of the diameter of the storage area for 1/2 length of storage vault or any point depth exceeds 15% of diameter. (Example: 72-inch storage tank would require cleaning when sediment reaches depth of 7 inches for more than 1/2 length of tank.)	All sediment and debris removed from storage area.
	Joints Between Tank/Pipe Section	Any openings or voids allowing material to be transported into facility. (Will require engineering analysis to determine structural stability).	All joint between tank/pipe sections are sealed.
	Tank Pipe Bent Out of Shape	Any part of tank/pipe is bent out of shape more than 10% of its design shape. (Review required by engineer to determine structural stability).	Tank/pipe repaired or replaced to design.
	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch and any evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determines that the vault is not structurally sound. Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or any evidence of soil particles entering the vault through the walls.	Vault replaced or repaired to design specifications and is structurally sound. No cracks more than 1/4-inch wide at the joint of the inlet/outlet pipe.
Manhole	Cover Not in Place	Cover is missing or only partially in place. Any open manhole requires maintenance.	Manhole is closed.

**Table V-4.5.2(3) Maintenance Standards - Closed Detention Systems
(Tanks/Vaults) (continued)**

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread (may not apply to self-locking lids).	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. Intent is to keep cover from sealing off access to maintenance.	Cover can be removed and reinstalled by one maintenance person.
	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, misalignment, not securely attached to structure wall, rust, or cracks.	Ladder meets design standards. Allows maintenance person safe access.
Catch Basins	See "Catch Basins" (No. 5)	See "Catch Basins" (No. 5).	See "Catch Basins" (No. 5).

Table V-4.5.2(4) Maintenance Standards - Control Structure/Flow Restrictor

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris (Includes Sediment)	Material exceeds 25% of sump depth or 1 foot below orifice plate.	Control structure orifice is not blocked. All trash and debris removed.
	Structural Damage	Structure is not securely attached to manhole wall. Structure is not in upright position (allow up to 10% from plumb). Connections to outlet pipe	Structure securely attached to wall and outlet pipe. Structure in correct position. Connections to outlet pipe are water tight; structure repaired or replaced and works as

Table V-4.5.2(4) Maintenance Standards - Control Structure/Flow Restrictor (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
		are not watertight and show signs of rust. Any holes - other than designed holes - in the structure.	designed. Structure has no holes other than designed holes.
Cleanout Gate	Damaged or Missing	Cleanout gate is not watertight or is missing. Gate cannot be moved up and down by one maintenance person. Chain/rod leading to gate is missing or damaged. Gate is rusted over 50% of its surface area.	Gate is watertight and works as designed. Gate moves up and down easily and is watertight. Chain is in place and works as designed. Gate is repaired or replaced to meet design standards.
Orifice Plate	Damaged or Missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.
	Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
Overflow Pipe	Obstructions	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.
Manhole	See "Closed Detention Systems" (No. 3).	See "Closed Detention Systems" (No. 3).	See "Closed Detention Systems" (No. 3).
Catch Basin	See "Catch Basins" (No. 5).	See "Catch Basins" (No. 5).	See "Catch Basins" (No. 5).

Table V-4.5.2(5) Maintenance Standards - Catch Basins

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
General	Trash & Debris	<p>Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10%.</p> <p>Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe.</p> <p>Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height.</p> <p>Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).</p>	<p>No Trash or debris located immediately in front of catch basin or on grate opening.</p> <p>No trash or debris in the catch basin.</p> <p>Inlet and outlet pipes free of trash or debris.</p> <p>No dead animals or vegetation present within the catch basin.</p>
	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the catch basin
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch. (Intent is to make sure no material is running into basin).	Top slab is free of holes and cracks. Frame is sit-

Table V-4.5.2(5) Maintenance Standards - Catch Basins (continued)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
		Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached	ting flush on the riser rings or top slab and firmly attached.
	Fractures or Cracks in Basin Walls/ Bottom	Maintenance person judges that structure is unsound. Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Basin replaced or repaired to design standards. Pipe is regouted and secure at basin wall.
	Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
	Vegetation	Vegetation growing across and blocking more than 10% of the basin opening. Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation blocking opening to basin. No vegetation or root growth present.
	Contamination and Pollution	See "Detention Ponds" (No. 1).	No pollution present.
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is closed
	Locking Mechanism Not	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into	Mechanism opens with

Table V-4.5.2(5) Maintenance Standards - Catch Basins (continued)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
	Working	frame have less than 1/2 inch of thread.	proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. (Intent is keep cover from sealing off access to maintenance.)	Cover can be removed by one maintenance person.
Ladder	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, not securely attached to basin wall, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
Metal Grates (If Applicable)	Grate opening Unsafe	Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing.	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.

Table V-4.5.2(6) Maintenance Standards - Debris Barriers (e.g., Trash Racks)

Maintenance Components	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris	Trash or debris that is plugging more than 20% of the openings in the barrier.	Barrier cleared to design flow capacity.
Metal	Damaged/ Missing	Bars are bent out of shape more than 3 inches.	Bars in place with no bends more than 3/4

Table V-4.5.2(6) Maintenance Standards - Debris Barriers (e.g., Trash Racks) (continued)

Maintenance Components	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
	Bars.	Bars are missing or entire barrier missing. Bars are loose and rust is causing 50% deterioration to any part of barrier.	inch. Bars in place according to design. Barrier replaced or repaired to design standards.
	Inlet/Outlet Pipe	Debris barrier missing or not attached to pipe	Barrier firmly attached to pipe

Table V-4.5.2(7) Maintenance Standards - Energy Dissipaters

Maintenance Components	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
External:			
Rock Pad	Missing or Moved Rock	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil.	Rock pad replaced to design standards.
	Erosion	Soil erosion in or adjacent to rock pad.	Rock pad replaced to design standards.
Dispersion Trench	Pipe Plugged with Sediment	Accumulated sediment that exceeds 20% of the design depth.	Pipe cleaned/flushed so that it matches design.
	Not Discharging Water Properly	Visual evidence of water discharging at concentrated points along trench (normal condition is a "sheet flow" of water along trench). Intent is to prevent erosion damage.	Trench redesigned or rebuilt to standards.
	Perforations Plugged.	Over 1/2 of perforations in pipe are plugged with debris and sediment.	Perforated pipe cleaned or replaced.

**Table V-4.5.2(7) Maintenance Standards - Energy Dissipaters
(continued)**

Maintenance Components	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
	Water Flows Out Top of "Distributor" Catch Basin.	Maintenance person observes or receives credible report of water flowing out during any storm less than the design storm or its causing or appears likely to cause damage.	Facility rebuilt or redesigned to standards.
	Receiving Area Over-Saturated	Water in receiving area is causing or has potential of causing landslide problems.	No danger of landslides.
Internal:			
Manhole/Chamber	Worn or Damaged Post, Baffles, Side of Chamber	Structure dissipating flow deteriorates to 1/2 of original size or any concentrated worn spot exceeding one square foot which would make structure unsound.	Structure replaced to design standards.
	Other Defects	See "Catch Basins" (No. 5).	See "Catch Basins" (No. 5).

Table V-4.5.2(8) Maintenance Standards - Typical Biofiltration Swale

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation on Grass	Sediment depth exceeds 2 inches.	Remove sediment deposits on grass treatment area of the bio-swale. When finished, swale should be level from side to side and drain freely toward outlet. There should be no areas of standing water once inflow has ceased.
	Standing Water	When water stands in the swale between storms and does not drain freely.	Any of the following may apply: remove sediment or trash blockages, improve grade from head to foot of swale, remove clogged check dams, add underdrains or convert to a wet

**Table V-4.5.2(8) Maintenance Standards - Typical Biofiltration Swale
(continued)**

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
			biofiltration swale.

**Table V-4.5.2(8) Maintenance Standards - Typical Biofiltration Swale
(continued)**

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
	Flow spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire swale width.	Level the spreader and clean so that flows are spread evenly over entire swale width.
	Constant Base-flow	When small quantities of water continually flow through the swale, even when it has been dry for weeks, and an eroded, muddy channel has formed in the swale bottom.	Add a low-flow pea-gravel drain the length of the swale or by-pass the baseflow around the swale.
	Poor Vegetation Coverage	When grass is sparse or bare or eroded patches occur in more than 10% of the swale bottom.	Determine why grass growth is poor and correct that condition. Re-plant with plugs of grass from the upper slope: plant in the swale bottom at 8-inch intervals. Or re-seed into loosened, fertile soil.
	Vegetation	When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.	Mow vegetation or remove nuisance vegetation so that flow not impeded. Grass should be mowed to a height of 3 to 4 inches. Remove grass clippings.
	Excessive Shading	Grass growth is poor because sunlight does not reach swale.	If possible, trim back over-hanging limbs and remove brushy vegetation on adjacent slopes.

**Table V-4.5.2(8) Maintenance Standards - Typical Biofiltration Swale
(continued)**

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
	Inlet/Outlet	Inlet/outlet areas clogged with sediment and/or debris.	Remove material so that there is no clogging or blockage in the inlet and outlet area.
	Trash and Debris Accumulation	Trash and debris accumulated in the bio-swale.	Remove trash and debris from bioswale.
	Erosion/Scouring	Eroded or scoured swale bottom due to flow channelization, or higher flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. If bare areas are large, generally greater than 12 inches wide, the swale should be re-graded and re-seeded. For smaller bare areas, overseed when bare spots are evident, or take plugs of grass from the upper slope and plant in the swale bottom at 8-inch intervals.

Table V-4.5.2(9) Maintenance Standards - Wet Biofiltration Swale

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation	Sediment depth exceeds 2-inches in 10% of the swale treatment area.	Remove sediment deposits in treatment area.
	Water Depth	Water not retained to a depth of about 4 inches during the wet season.	Build up or repair outlet berm so that water is retained in the wet swale.
	Wetland Vegetation	Vegetation becomes sparse and does not provide adequate filtration, OR vegetation is crowded out	Determine cause of lack of vigor of vegetation and correct. Replant as needed. For excessive cattail growth, cut cattail shoots back and compost off-site.

**Table V-4.5.2(9) Maintenance Standards - Wet Biofiltration Swale
(continued)**

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
		by very dense clumps of cattail, which do not allow water to flow through the clumps.	Note: normally wetland vegetation does not need to be harvested unless die-back is causing oxygen depletion in downstream waters.
	Inlet/Outlet	Inlet/outlet area clogged with sediment and/or debris.	Remove clogging or blockage in the inlet and outlet areas.
	Trash and Debris Accumulation	See "Detention Ponds" (No. 1).	Remove trash and debris from wet swale.
	Erosion/Scouring	Swale has eroded or scoured due to flow channelization, or higher flows.	Check design flows to assure swale is large enough to handle flows. By-pass excess flows or enlarge swale. Replant eroded areas with fibrous-rooted plants such as <i>Juncus effusus</i> (soft rush) in wet areas or snowberry (<i>Symphoricarpos albus</i>) in dryer areas.

Table V-4.5.2(10) Maintenance Standards - Filter Strips

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation on Grass	Sediment depth exceeds 2 inches.	Remove sediment deposits, re-level so slope is even and flows pass evenly through strip.
	Vegetation	When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other veget-	Mow grass, control nuisance vegetation, such that flow not impeded. Grass should be mowed to a height between 3-4 inches.

Table V-4.5.2(10) Maintenance Standards - Filter Strips (continued)

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
		ation starts to take over.	
	Trash and Debris Accumulation	Trash and debris accumulated on the filter strip.	Remove trash and Debris from filter.
	Erosion/Scouring	Eroded or scoured areas due to flow channelization, or higher flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. The grass will creep in over the rock in time. If bare areas are large, generally greater than 12 inches wide, the filter strip should be re-graded and re-seeded. For smaller bare areas, over-seed when bare spots are evident.
	Flow spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire filter width.	Level the spreader and clean so that flows are spread evenly over entire filter width.

Table V-4.5.2(11) Maintenance Standards - Wetponds

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Water level	First cell is empty, doesn't hold water.	Line the first cell to maintain at least 4 feet of water. Although the second cell may drain, the first cell must remain full to control turbulence of the incoming flow and reduce sediment resuspension.
	Trash and Debris	Accumulation that exceeds 1 CF per	Trash and debris removed from pond.

Table V-4.5.2(11) Maintenance Standards - Wetponds (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
		1000-SF of pond area.	
	Inlet/Outlet Pipe	Inlet/Outlet pipe clogged with sediment and/or debris material.	No clogging or blockage in the inlet and outlet piping.
	Sediment Accumulation in Pond Bottom	Sediment accumulations in pond bottom that exceeds the depth of sediment zone plus 6-inches, usually in the first cell.	Sediment removed from pond bottom.
	Oil Sheen on Water	Prevalent and visible oil sheen.	Oil removed from water using oil-absorbent pads or vacuor truck. Source of oil located and corrected. If chronic low levels of oil persist, plant wetland plants such as Juncus effusus (soft rush) which can uptake small concentrations of oil.
	Erosion	Erosion of the pond's side slopes and/or scouring of the pond bottom, that exceeds 6-inches, or where continued erosion is prevalent.	Slopes stabilized using proper erosion control measures and repair methods.
	Settlement of Pond Dike/Berm	Any part of these components that has settled 4-inches or lower than the design elevation, or inspector determines dike/berm is unsound.	Dike/berm is repaired to specifications.
	Internal Berm	Berm dividing cells should be level.	Berm surface is leveled so that water flows evenly over entire length of

Table V-4.5.2(11) Maintenance Standards - Wetponds (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
			berm.
	Overflow Spillway	Rock is missing and soil is exposed at top of spillway or outside slope.	Rocks replaced to specifications.

Table V-4.5.2(12) Maintenance Standards - Wetvaults

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash/Debris Accumulation	Trash and debris accumulated in vault, pipe or inlet/outlet (includes floatables and non-floatables).	Remove trash and debris from vault.
	Sediment Accumulation in Vault	Sediment accumulation in vault bottom exceeds the depth of the sediment zone plus 6-inches.	Remove sediment from vault.
	Damaged Pipes	Inlet/outlet piping damaged or broken and in need of repair.	Pipe repaired and/or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened or removed, especially by one person.	Pipe repaired or replaced to proper working specifications.
	Ventilation	Ventilation area blocked or plugged.	Blocking material removed or cleared from ventilation area. A specified % of the vault surface area must provide ventilation to the vault interior (see design specifications).
	Vault Structure Damage - Includes Cracks in Walls Bottom, Damage to	Maintenance/inspection personnel determine that the vault is not structurally sound. Cracks wider than 1/2-	Vault replaced or repairs made so that vault meets design specifications and is structurally sound. Vault repaired so that no cracks

Table V-4.5.2(12) Maintenance Standards - Wetvaults (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
	Frame and/or Top Slab	inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection staff.	Baffles repaired or replaced to specifications.
	Access Ladder Damage	Ladder is corroded or deteriorated, not functioning properly, not attached to structure wall, missing rungs, has cracks and/or misaligned. Confined space warning sign missing.	Ladder replaced or repaired to specifications, and is safe to use as determined by inspection personnel. Replace sign warning of confined space entry requirements. Ladder and entry notification complies with OSHA standards.

Table V-4.5.2(13) Maintenance Standards - Sand Filters (Above Ground/Open)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Above Ground (open sand filter)	Sediment Accumulation on top layer	Sediment depth exceeds 1/2-inch.	No sediment deposit on grass layer of sand filter that would impede permeability of the filter section.
	Trash and Debris Accumulations	Trash and debris accumulated on sand filter bed.	Trash and debris removed from sand filter bed.
	Sediment/Debris in Clean-Outs	When the clean-outs become full or partially plugged with sediment and/or debris.	Sediment removed from clean-outs.
	Sand Filter Media	Drawdown of water through the sand filter media takes longer than 24-hours, and/or flow	Top several inches of sand are scraped. May require replacement of entire sand filter depth depending on extent of plugging

Table V-4.5.2(13) Maintenance Standards - Sand Filters (Above Ground/Open) (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
		through the overflow pipes occurs frequently.	(a sieve analysis is helpful to determine if the lower sand has too high a proportion of fine material).
	Prolonged Flows	Sand is saturated for prolonged periods of time (several weeks) and does not dry out between storms due to continuous base flow or prolonged flows from detention facilities.	Low, continuous flows are limited to a small portion of the facility by using a low wooden divider or slightly depressed sand surface.
	Short Cir-cuiting	When flows become concentrated over one section of the sand filter rather than dispersed.	Flow and percolation of water through sand filter is uniform and dispersed across the entire filter area.
	Erosion Damage to Slopes	Erosion over 2-inches deep where cause of damage is prevalent or potential for continued erosion is evident.	Slopes stabilized using proper erosion control measures.
	Rock Pad Missing or Out of Place	Soil beneath the rock is visible.	Rock pad replaced or rebuilt to design specifications.
	Flow Spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed across sand filter.	Spreader leveled and cleaned so that flows are spread evenly over sand filter.
	Damaged Pipes	Any part of the piping that is crushed or deformed more than 20% or any other failure to the piping.	Pipe repaired or replaced.

Table V-4.5.2(14) Maintenance Standards - Sand Filters (Below Ground/Enclosed)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Below Ground Vault.	Sediment Accumulation on Sand Media Section	Sediment depth exceeds 1 1/2-inch.	No sediment deposits on sand filter section that which would impede permeability of the filter section.
	Sediment Accumulation in Pre-Settling Portion of Vault	Sediment accumulation in vault bottom exceeds the depth of the sediment zone plus 6-inches.	No sediment deposits in first chamber of vault.
	Trash/Debris Accumulation	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault and inlet/outlet piping.
	Sediment in Drain Pipes/Cleanouts	When drain pipes, cleanouts become full with sediment and/or debris.	Sediment and debris removed.
	Short Circuiting	When seepage/flow occurs along the vault walls and corners. Sand eroding near inflow area.	Sand filter media section re-laid and compacted along perimeter of vault to form a semi-seal. Erosion protection added to dissipate force of incoming flow and curtail erosion.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired and/or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened, corrosion/deformation of cover. Maintenance person cannot remove cover using normal lifting pressure.	Cover repaired to proper working specifications or replaced.
	Ventilation	Ventilation area blocked or plugged	Blocking material removed or cleared from ventilation

Table V-4.5.2(14) Maintenance Standards - Sand Filters (Below Ground/Enclosed) (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
			area. A specified % of the vault surface area must provide ventilation to the vault interior (see design specifications).
	Vault Structure Damaged; Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab.	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound. Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound. Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles/Internal walls	Baffles or walls corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired to specifications, and is safe to use as determined by inspection personnel.

Table V-4.5.2(15) Maintenance Standards - Manufactured Media Filters

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Below Ground Vault	Sediment Accumulation	Sediment depth exceeds 0.25-inches.	No sediment deposits

**Table V-4.5.2(15) Maintenance Standards - Manufactured Media Filters
(continued)**

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
	mulation on Media.		its which would impede permeability of the compost media.
	Sediment Accumulation in Vault	Sediment depth exceeds 6-inches in first chamber.	No sediment deposits in vault bottom of first chamber.
	Trash/Debris Accumulation	Trash and debris accumulated on compost filter bed.	Trash and debris removed from the compost filter bed.
	Sediment in Drain Pipes/Clean-Outs	When drain pipes, clean-outs, become full with sediment and/or debris.	Sediment and debris removed.
	Damaged Pipes	Any part of the pipes that are crushed or damaged due to corrosion and/or settlement.	Pipe repaired and/or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened; one person cannot open the cover using normal lifting pressure, corrosion/deformation of cover.	Cover repaired to proper working specifications or replaced.
	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound. Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound. Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles	Baffles corroding, cracking warping, and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.

**Table V-4.5.2(15) Maintenance Standards - Manufactured Media Filters
(continued)**

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and mis-aligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.
Below Ground Cartridge Type	Media	Drawdown of water through the media takes longer than 1 hour, and/or overflow occurs frequently.	Media cartridges replaced.
	Short Circuiting	Flows do not properly enter filter cartridges.	Filter cartridges replaced.

**Table V-4.5.2(16) Maintenance Standards - Baffle Oil/Water Separators
(API Type)**

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Monitoring	Inspection of discharge water for obvious signs of poor water quality.	Effluent discharge from vault should be clear with out thick visible sheen.
	Sediment Accumulation	Sediment depth in bottom of vault exceeds 6-inches in depth.	No sediment deposits on vault bottom that would impede flow through the vault and reduce separation efficiency.
	Trash and Debris Accumulation	Trash and debris accumulation in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault, and inlet/outlet piping.
	Oil Accumulation	Oil accumulations that exceed 1-inch, at the surface of the water.	Extract oil from vault by vactoring. Disposal in accordance with state and local rules and regulations.

**Table V-4.5.2(16) Maintenance Standards - Baffle Oil/Water Separators
(API Type) (continued)**

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened, corrosion/deformation of cover.	Cover repaired to proper working specifications or replaced.
	Vault Structure Damage - Includes Cracks in Walls Bottom, Damage to Frame and/or Top Slab	See "Catch Basins" (No. 5) Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound. Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.

Table V-4.5.2(17) Maintenance Standards - Coalescing Plate Oil/Water Separators

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Monitoring	Inspection of discharge water for obvious signs of poor water	Effluent discharge from vault should be clear with

Table V-4.5.2(17) Maintenance Standards - Coalescing Plate Oil/Water Separators (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
		quality.	no thick visible sheen.

Table V-4.5.2(17) Maintenance Standards - Coalescing Plate Oil/Water Separators (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
	Sediment Accumulation	Sediment depth in bottom of vault exceeds 6-inches in depth and/or visible signs of sediment on plates.	No sediment deposits on vault bottom and plate media, which would impede flow through the vault and reduce separation efficiency.
	Trash and Debris Accumulation	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault, and inlet/outlet piping.
	Oil Accumulation	Oil accumulation that exceeds 1-inch at the water surface.	Oil is extracted from vault using vactoring methods. Coalescing plates are cleaned by thoroughly rinsing and flushing. Should be no visible oil depth on water.
	Damaged Coalescing Plates	Plate media broken, deformed, cracked and/or showing signs of failure.	A portion of the media pack or the entire plate pack is replaced depending on severity of failure.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired and or replaced.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Vault Structure Damage - Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound. Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the

Table V-4.5.2(17) Maintenance Standards - Coalescing Plate Oil/Water Separators (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
		Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	inlet/outlet pipe.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.

Table V-4.5.2(18) Maintenance Standards - Catch Basin Inserts

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Sediment Accumulation	When sediment forms a cap over the insert media of the insert and/or unit.	No sediment cap on the insert media and its unit.
	Trash and Debris Accumulation	Trash and debris accumulates on insert unit creating a blockage/restriction.	Trash and debris removed from insert unit. Runoff freely flows into catch basin.
	Media Insert Not Removing Oil	Effluent water from media insert has a visible sheen.	Effluent water from media insert is free of oils and has no visible sheen.
	Media Insert Water Saturated	Catch basin insert is saturated with water and no longer has the capacity to absorb.	Remove and replace media insert
	Media Insert-Oil Saturated	Media oil saturated due to petroleum spill that drains into catch basin.	Remove and replace media insert.
	Media Insert Use Beyond Product Life	Media has been used beyond the typical average life of media insert product.	Remove and replace media at regular intervals, depending on insert product.

Table V-4.5.2(19) Maintenance Standards - Media Filter Drain (MFD)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Sediment accumulation on grass filter strip	Sediment depth exceeds 2 inches or creates uneven grading that interferes with sheet flow.	Remove sediment deposits on grass treatment area of the embankment. When finished, embankment should be level from side to side and drain freely toward the toe of the embankment slope. There should be no areas of standing water once inflow has ceased.
	No-vegetation zone/-flow spreader	Flow spreader is uneven or clogged so that flows are not uniformly distributed over entire embankment width.	Level the spreader and clean to spread flows evenly over entire embankment width.
	Poor vegetation coverage	Grass is sparse or bare, or eroded patches are observed in more than 10% of the grass strip surface area.	Determine why grass growth is poor and correct the offending condition. Reseed into loosened, fertile soil or compost; or, replant with plugs of grass from the upper slope.
	Vegetation	Grass becomes excessively tall (greater than 10 inches); nuisance weeds and other vegetation start to take over.	Mow vegetation or remove nuisance vegetation to not impede flow. Mow grass to a height of 6 inches.
	Media filter drain mix replacement	Water is seen on the surface of the media filter drain mix long after the storms have ceased. Typically, the 6-month, 24-hour precipitation event should drain within 48 hours. More common storms should drain within 24 hours. Maintenance also needed on a 10-year cycle and during a preservation project.	Excavate and replace all of the media filter drain mix contained within the media filter drain.
	Excessive shading	Grass growth is poor because sunlight does not reach	If possible, trim back overhanging limbs and remove

Table V-4.5.2(19) Maintenance Standards - Media Filter Drain (MFD)
(continued)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
		embankment.	brushy vegetation on adjacent slopes.
	Trash and debris	Trash and debris have accumulated on embankment.	Remove trash and debris from embankment.
	Flooding of Media filter drain	When media filter drain is inundated by flood water	Evaluate media filter drain material for acceptable infiltration rate and replace if media filter drain does not meet long-term infiltration rate standards.

Table V-4.5.2(20) Maintenance Standards - Compost Amended Vegetated Filter Strip (CAVFS)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Sediment accumulation on grass	Sediment depth exceeds 2 inches.	Remove sediment deposits. Relevel so slope is even and flows pass evenly through strip.
	Vegetation	Grass becomes excessively tall (greater than 10 inches); nuisance weeds and other vegetation start to take over.	Mow grass and control nuisance vegetation so that flow is not impeded. Grass should be mowed to a height of 6 inches.
	Trash and debris	Trash and debris have accumulated on the vegetated filter strip.	Remove trash and debris from filter.

**Table V-4.5.2(20) Maintenance Standards - Compost Amended
Vegetated Filter Strip (CAVFS) (continued)**

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
	Erosion/scouring	Areas have eroded or scoured due to flow channelization or high flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with a 50/50 mixture of crushed gravel and compost. The grass will creep in over the rock in time. If bare areas are large, generally greater than 12 inches wide, the vegetated filter strip should be regraded and reseeded. For smaller bare areas, overseed when bare spots are evident.
	Flow spreader	Flow spreader is uneven or clogged so that flows are not uniformly distributed over entire filter width.	Level the spreader and clean so that flows are spread evenly over entire filter width

Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Facility Footprint				
Earthen side slopes and berms	B, S		Erosion (gullies/rills) greater than 2 inches deep around inlets, outlet, and alongside slopes	<ul style="list-style-type: none">• Eliminate cause of erosion and stabilize damaged area (regrade, rock, vegetation, erosion control matting)• For deep channels or cuts (over 3 inches in ponding

**Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities
(continued)**

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				depth), temporary erosion control measures should be put in place until permanent repairs can be made. <ul style="list-style-type: none"> Properly designed, constructed and established facilities with appropriate flow velocities should not have erosion problems except perhaps in extreme events. If erosion problems persist, the following should be reassessed: (1) flow volumes from contributing areas and bioretention facility sizing; (2) flow velocities and gradients within the facility; and (3) flow dissipation and erosion protection strategies at the facility inlet.
	A		Erosion of sides causes slope to become a hazard	Take actions to eliminate the hazard and stabilize slopes
	A, S		Settlement greater than 3	Restore to design height

**Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities
(continued)**

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
			inches (relative to undisturbed sections of berm)	
	A, S		Downstream face of berm wet, seeps or leaks evident	Plug any holes and compact berm (may require consultation with engineer, particularly for larger berms)
	A		Any evidence of rodent holes or water piping in berm	<ul style="list-style-type: none"> • Eradicate rodents (see "Pest control") • Fill holes and compact (may require consultation with engineer, particularly for larger berms)
Concrete side-walls	A		Cracks or failure of concrete side-walls	<ul style="list-style-type: none"> • Repair/ seal cracks • Replace if repair is insufficient
Rockery side-walls	A		Rockery side-walls are insecure	Stabilize rockery side-walls (may require consultation with engineer, particularly for walls 4 feet or greater in height)
Facility area		All maintenance visits (at least biannually)	Trash and debris present	Clean out trash and debris
Facility bottom area	A, S		Accumulated sediment to extent that infiltration rate is	<ul style="list-style-type: none"> • Remove excess sediment • Replace any vegetation damaged or

**Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities
(continued)**

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
			reduced (see "Ponded water") or surface storage capacity significantly impacted	<p>destroyed by sediment accumulation and removal</p> <ul style="list-style-type: none"> • Mulch newly planted vegetation • Identify and control the sediment source (if feasible) • If accumulated sediment is recurrent, consider adding pre-settlement or installing berms to create a forebay at the inlet
		During/after fall leaf drop	Accumulated leaves in facility	Remove leaves if there is a risk to clogging outlet structure or water flow is impeded
Low permeability check dams and weirs	A, S		Sediment, vegetation, or debris accumulated at or blocking (or having the potential to block) check dam, flow control weir or orifice	Clear the blockage
	A, S		Erosion and/or undercutting present	Repair and take preventative measures to prevent future erosion and/or undercutting

**Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities
(continued)**

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
	A		Grade board or top of weir damaged or not level	Restore to level position
Ponded water	B, S		Excessive ponding water: Water overflows during storms smaller than the design event or ponded water remains in the basin 48 hours or longer after the end of a storm.	<p>Determine cause and resolve in the following order:</p> <ol style="list-style-type: none"> 1. Confirm leaf or debris buildup in the bottom of the facility is not impeding infiltration. If necessary, remove leaf litter/debris. 2. Ensure that under-drain (if present) is not clogged. If necessary, clear under-drain. 3. Check for other water inputs (e.g., groundwater, illicit connections). 4. Verify that the facility is sized appropriately for the contributing area. Confirm that the contributing area has not increased. If steps #1-4 do not solve the problem,

**Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities
(continued)**

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				the bioretention soil is likely clogged by sediment accumulation at the surface or has become overly compacted. Dig a small hole to observe soil profile and identify compaction depth or clogging front to help determine the soil depth to be removed or otherwise rehabilitated (e.g., tilled). Consultation with an engineer is recommended.
Bioretention soil media	As needed		Bioretention soil media protection is needed when performing maintenance requiring entrance into the facility footprint	<ul style="list-style-type: none"> • Minimize all loading in the facility footprint (foot traffic and other loads) to the degree feasible in order to prevent compaction of bioretention soils. • Never drive equipment or apply heavy loads in facility footprint. • Because the risk of compaction is higher during saturated soil

**Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities
(continued)**

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				conditions, any type of loading in the cell (including foot traffic) should be minimized during wet conditions. • Consider measures to distribute loading if heavy foot traffic is required or equipment must be placed in facility. As an example, boards may be placed across soil to distribute loads and minimize compaction. • If compaction occurs, soil must be loosened or otherwise rehabilitated to original design state.
Inlets/Outlets/Pipes				
Splash block inlet	A		Water is not being directed properly to the facility and away from the inlet structure	Reconfigure/ repair blocks to direct water to facility and away from structure
Curb cut inlet/outlet	M during the wet season and before severe storm	Weekly during fall leaf drop	Accumulated leaves at curb cuts	Clear leaves (particularly important for key inlets and low points along long, linear facilities)

**Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities
(continued)**

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
	is forecasted			
Pipe inlet/outlet	A		Pipe is damaged	Repair/ replace
	W		Pipe is clogged	Remove roots or debris
	A, S		Sediment, debris, trash, or mulch reducing capacity of inlet/outlet	<ul style="list-style-type: none"> • Clear the blockage • Identify the source of the blockage and take actions to prevent future blockages
		Weekly during fall leaf drop	Accumulated leaves at inlets/outlets	Clear leaves (particularly important for key inlets and low points along long, linear facilities)
		A	Maintain access for inspections	<ul style="list-style-type: none"> • Clear vegetation (transplant vegetation when possible) within 1 foot of inlets and outlets, maintain access pathways • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
Erosion control at inlet	A		Concentrated flows are causing erosion	Maintain a cover of rock or cobbles or other erosion protection measure (e.g., matting) to protect the ground where concentrated water enters the facility (e.g., a pipe, curb

**Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities
(continued)**

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				cut or swale)
Trash rack	S		Trash or other debris present on trash rack	Remove/dispose
	A		Bar screen damaged or missing	Repair/replace
Overflow	A, S		Capacity reduced by sediment or debris	Remove sediment or debris/dispose
Underdrain pipe	Clean pipe as needed	Clean orifice at least biannually (may need more frequent cleaning during wet season)	<ul style="list-style-type: none"> Plant roots, sediment or debris reducing capacity of underdrain Prolonged surface ponding (see "Ponded water") 	<ul style="list-style-type: none"> Jet clean or rotary cut debris/roots from underdrain(s) If underdrains are equipped with a flow restrictor (e.g., orifice) to attenuate flows, the orifice must be cleaned regularly.
Vegetation				
Facility bottom area and upland slope vegetation	Fall and Spring		Vegetation survival rate falls below 75% within first two years of establishment (unless project O&M manual or record drawing stipulates more	<ul style="list-style-type: none"> Determine cause of poor vegetation growth and correct condition Replant as necessary to obtain 75% survival rate or greater. Refer to original planting plan, or approved jur-

**Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities
(continued)**

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
			or less than 75% survival rate).	<p>isdictional species list for appropriate plant replacements (See Appendix 3 - Bioretention Plant List, in the LID Technical Guidance Manual for Puget Sound).</p> <ul style="list-style-type: none"> • Confirm that plant selection is appropriate for site growing conditions • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
Vegetation (general)	As needed		Presence of diseased plants and plant material	<ul style="list-style-type: none"> • Remove any diseased plants or plant parts and dispose of in an approved location (e.g., commercial landfill) to avoid risk of spreading the disease to other plants • Disinfect gardening tools after pruning to prevent the spread of disease • See Pacific North-

**Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities
(continued)**

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				<p>west Plant Disease Management Handbook for information on disease recognition and for additional resources</p> <ul style="list-style-type: none"> • Replant as necessary according to recommendations provided for "facility bottom area and upland slope vegetation".
Trees and shrubs		All pruning seasons (timing varies by species)	Pruning as needed	<ul style="list-style-type: none"> • Prune trees and shrubs in a manner appropriate for each species. Pruning should be performed by landscape professionals familiar with proper pruning techniques • All pruning of mature trees should be performed by or under the direct guidance of an ISA certified arborist
	A		Large trees and shrubs interfere with operation of the facility or access for maintenance	<ul style="list-style-type: none"> • Prune trees and shrubs using most current ANSI A300 standards and ISA BMPs. • Remove trees and

**Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities
(continued)**

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				shrubs, if necessary.

**Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities
(continued)**

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
	Fall and Spring		Standing dead vegetation is present	<ul style="list-style-type: none"> • Remove standing dead vegetation • Replace dead vegetation within 30 days of reported dead and dying plants (as practical depending on weather/planting season) • If vegetation replacement is not feasible within 30 days, and absence of vegetation may result in erosion problems, temporary erosion control measures should be put in place immediately. • Determine cause of dead vegetation and address issue, if possible • If specific plants have a high mortality rate, assess the cause and replace with appropriate species. Consultation with a landscape architect is recommended.
	Fall and		Planting	<ul style="list-style-type: none"> • When working

**Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities
(continued)**

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
	Spring		beneath mature trees	<p>around and below mature trees, follow the most current ANSI A300 standards and ISA BMPs to the extent practicable (e.g., take care to minimize any damage to tree roots and avoid compaction of soil).</p> <ul style="list-style-type: none"> Planting of small shrubs or ground-covers beneath mature trees may be desirable in some cases; such plantings should use mainly plants that come as bulbs, bare root or in 4-inch pots; plants should be in no larger than 1-gallon containers.
	Fall and Spring		Presence of or need for stakes and guys (tree growth, maturation, and support needs)	<ul style="list-style-type: none"> Verify location of facility liners and underdrain (if any) prior to stake installation in order to prevent liner puncture or pipe damage Monitor tree support systems: Repair and adjust as needed to

**Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities
(continued)**

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Trees and shrubs adjacent to vehicle travel areas (or areas where visibility needs to be maintained)				<p>provide support and prevent damage to tree.</p> <ul style="list-style-type: none"> Remove tree supports (stakes, guys, etc.) after one growing season or maximum of 1 year. Backfill stake holes after removal.
	A		Vegetation causes some visibility (line of sight) or driver safety issues	<ul style="list-style-type: none"> Maintain appropriate height for sight clearance When continued, regular pruning (more than one time/ growing season) is required to maintain visual sight lines for safety or clearance along a walk or drive, consider relocating the plant to a more appropriate location. Remove or transplant if continual safety hazard Consultation with a landscape architect is recommended for removal, transplant, or substitution of

**Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities
(continued)**

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				plants
Flowering plants		A	Dead or spent flowers present	Remove spent flowers (deadhead)
Perennials		Fall	Spent plants	Cut back dying or dead and fallen foliage and stems
Emergent vegetation		Spring	Vegetation compromises conveyance	Hand rake sedges and rushes with a small rake or fingers to remove dead foliage before new growth emerges in spring or earlier only if the foliage is blocking water flow (sedges and rushes do not respond well to pruning)
Ornamental grasses (perennial)		Winter and Spring	Dead material from previous year's growing cycle or dead collapsed foliage	<ul style="list-style-type: none"> • Leave dry foliage for winter interest • Hand rake with a small rake or fingers to remove dead foliage back to within several inches from the soil before new growth emerges in spring or earlier if the foliage collapses and is blocking water flow
Ornamental grasses (evergreen)		Fall and Spring	Dead growth present in spring	<ul style="list-style-type: none"> • Hand rake with a small rake or fingers to remove dead growth before new growth emerges in spring

**Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities
(continued)**

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				<ul style="list-style-type: none"> • Clean, rake, and comb grasses when they become too tall • Cut back to ground or thin every 2-3 years as needed
Noxious weeds		M (March - October, preceding seed dispersal)	Listed noxious vegetation is present (refer to current county noxious weed list)	<ul style="list-style-type: none"> • By law, class A & B noxious weeds must be removed, bagged and disposed as garbage immediately • Reasonable attempts must be made to remove and dispose of class C noxious weeds • It is strongly encouraged that herbicides and pesticides not be used in order to protect water quality; use of herbicides and pesticides may be prohibited in some jurisdictions • Apply mulch after weed removal (see "Mulch")
Weeds		M (March - October, preceding seed dispersal)	Weeds are present	<ul style="list-style-type: none"> • Remove weeds with their roots manually with pincer-type weeding tools, flame

**Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities
(continued)**

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				<p>weeders, or hot water weeders as appropriate</p> <ul style="list-style-type: none"> Follow IPM protocols for weed management (see "Additional Maintenance Resources" section for more information on IPM protocols)
Excessive vegetation		Once in early to mid- May and once in early- to mid-September	Low-lying vegetation growing beyond facility edge onto sidewalks, paths, or street edge poses pedestrian safety hazard or may clog adjacent permeable pavement surfaces due to associated leaf litter, mulch, and soil	<ul style="list-style-type: none"> Edge or trim groundcovers and shrubs at facility edge Avoid mechanical blade-type edger and do not use edger or trimmer within 2 feet of tree trunks While some clippings can be left in the facility to replenish organic material in the soil, excessive leaf litter can cause surface soil clogging
	As needed		Excessive vegetation density inhibits stormwater flow beyond design ponding or	<ul style="list-style-type: none"> Determine whether pruning or other routine maintenance is adequate to maintain proper plant density and aesthetics

**Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities
(continued)**

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
			becomes a hazard for pedestrian and vehicular circulation and safety	<ul style="list-style-type: none"> • Determine if planting type should be replaced to avoid ongoing maintenance issues (an aggressive grower under perfect growing conditions should be transplanted to a location where it will not impact flow) • Remove plants that are weak, broken or not true to form; replace in-kind • Thin grass or plants impacting facility function without leaving visual holes or bare soil areas • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
	As needed		Vegetation blocking curb cuts, causing excessive sediment buildup and flow bypass	Remove vegetation and sediment buildup

**Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities
(continued)**

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Mulch				
Mulch		Following weeding	Bare spots (without mulch cover) are present or mulch depth less than 2 inches	<ul style="list-style-type: none">• Supplement mulch with hand tools to a depth of 2 to 3 inches• Replenish mulch per O&M manual. Often coarse compost is used in the bottom of the facility and arborist wood chips are used on side slopes and rim (above typical water levels)• Keep all mulch away from woody stems
Watering				
Irrigation system (if any)		Based on manufacturer's instructions	Irrigation system present	Follow manufacturer's instructions for O&M
	A		Sprinklers or drip irrigation not directed/located to properly water plants	Redirect sprinklers or move drip irrigation to desired areas
Summer watering (first year)		Once every 1-2 weeks or as needed during prolonged dry periods	Trees, shrubs and ground-covers in first year of establishment period	<ul style="list-style-type: none">• 10 to 15 gallons per tree• 3 to 5 gallons per shrub• 2 gallons water per square foot for groundcover areas

**Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities
(continued)**

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				<ul style="list-style-type: none"> • Water deeply, but infrequently, so that the top 6 to 12 inches of the root zone is moist • Use soaker hoses or spot water with a shower type wand when irrigation system is not present <ul style="list-style-type: none"> ◦ Pulse water to enhance soil absorption, when feasible ◦ Pre-moisten soil to break surface tension of dry or hydrophobic soils/mulch, followed by several more passes. With this method, each pass increases soil absorption and allows more water to infiltrate prior to runoff • Add a tree bag or slow-release watering device (e.g.,

**Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities
(continued)**

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				bucket with a perforated bottom) for watering newly installed trees when irrigation system is not present
Summer watering (second and third years)		Once every 2-4 weeks or as needed during prolonged dry periods	Trees, shrubs and groundcovers in second or third year of establishment period	<ul style="list-style-type: none"> • 10 to 15 gallons per tree • 3 to 5 gallons per shrub • 2 gallons water per square foot for groundcover areas • Water deeply, but infrequently, so that the top 6 to 12 inches of the root zone is moist • Use soaker hoses or spot water with a shower type wand when irrigation system is not present <ul style="list-style-type: none"> ◦ Pulse water to enhance soil absorption, when feasible ◦ Pre-moisten soil to break surface tension of dry or hydrophobic soils/mulch, fol-

**Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities
(continued)**

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				lowed by several more passes. With this method , each pass increases soil absorption and allows more water to infiltrate prior to runoff
Summer watering (after establishment)		As needed	Established vegetation (after 3 years)	<ul style="list-style-type: none"> Plants are typically selected to be drought tolerant and not require regular watering after establishment; however, trees may take up to 5 years of watering to become fully established Identify trigger mechanisms for drought-stress (e.g., leaf wilt, leaf senescence, etc.) of different species and water immediately after initial signs of stress appear Water during drought conditions or more often if necessary to main-

**Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities
(continued)**

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				tain plant cover
Pest Control				
Mosquitoes	B, S		Standing water remains for more than 3 days after the end of a storm	<ul style="list-style-type: none"> Identify the cause of the standing water and take appropriate actions to address the problem (see "Ponded water") To facilitate maintenance, manually remove standing water and direct to the storm drainage system (if runoff is from non pollution-generating surfaces) or sanitary sewer system (if runoff is from pollution-generating surfaces) after getting approval from sanitary sewer authority. Use of pesticides or <i>Bacillus thuringiensis israelensis</i> (Bti) may be considered only as a temporary measure while addressing the standing water cause. If overflow to

**Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities
(continued)**

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				a surface water will occur within 2 weeks after pesticide use, apply for coverage under the Aquatic Mosquito Control NPDES General Permit.
Nuisance animals	As needed		Nuisance animals causing erosion, damaging plants, or depositing large volumes of feces	<ul style="list-style-type: none"> • Reduce site conditions that attract nuisance species where possible (e.g., plant shrubs and tall grasses to reduce open areas for geese, etc.) • Place predator decoys • Follow IPM protocols for specific nuisance animal issues (see "Additional Maintenance Resources" section for more information on IPM protocols) • Remove pet waste regularly • For public and right-of-way sites consider adding garbage cans with dog bags for picking

**Table V-4.5.2(21) Maintenance Standards - Bioretention Facilities
(continued)**

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				up pet waste.
Insect pests	Every site visit associated with vegetation management		Signs of pests, such as wilting leaves, chewed leaves and bark, spotting or other indicators	<ul style="list-style-type: none"> • Reduce hiding places for pests by removing diseased and dead plants • For infestations, follow IPM protocols (see "Additional Maintenance Resources" section for more information on IPM protocols)
<p>Note that the inspection and routine maintenance frequencies listed above are recommended by Ecology. They do not supersede or replace the municipal stormwater permit requirements for inspection frequency required of municipal stormwater permittees for "stormwater treatment and flow control BMPs/facilities".</p> <p>^a Frequency: A = Annually; B = Biannually (twice per year); M = Monthly; W = At least one visit should occur during the wet season (for debris/clog related maintenance, this inspection/maintenance visit should occur in the early fall, after deciduous trees have lost their leaves); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).</p> <p>IPM - Integrated Pest Management</p> <p>ISA - International Society of Arboriculture</p>				

Table V-4.5.2(22) Maintenance Standards - Permeable Pavement

Component	Recommended Frequency ^a		Condition when Main-ten- tance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Surface/Wearing Course				
Permeable	A, S		Runoff from	• Clean deposited soil or

**Table V-4.5.2(22) Maintenance Standards - Permeable Pavement
(continued)**

Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Pavements, all			adjacent pervious areas deposits soil, mulch or sediment on paving	<p>other materials from permeable pavement or other adjacent surfacing</p> <ul style="list-style-type: none"> • Check if surface elevation of planted area is too high, or slopes towards pavement, and can be regraded (prior to regrading, protect permeable pavement by covering with temporary plastic and secure covering in place) • Mulch and/or plant all exposed soils that may erode to pavement surface
Porous asphalt or pervious concrete		A or B	None (routine maintenance)	<p>Clean surface debris from pavement surface using one or a combination of the following methods:</p> <ul style="list-style-type: none"> • Remove sediment, debris, trash, vegetation, and other debris deposited onto pavement (rakes and leaf blowers can be used for removing leaves) • Vacuum/sweep permeable paving installation using: <ul style="list-style-type: none"> ◦ Walk-behind vacuum (sidewalks) ◦ High efficiency regenerative air or vacuum sweeper (roadways, parking lots)

**Table V-4.5.2(22) Maintenance Standards - Permeable Pavement
(continued)**

Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				<ul style="list-style-type: none"> ◦ ShopVac or brush brooms (small areas) • Hand held pressure washer or power washer with rotating brushes Follow equipment manufacturer guidelines for when equipment is most effective for cleaning permeable pavement. Dry weather is more effective for some equipment.
	A _b		Surface is clogged: Ponding on surface or water flows off the permeable pavement surface during a rain event (does not infiltrate)	<ul style="list-style-type: none"> • Review the overall performance of the facility (note that small clogged areas may not reduce overall performance of facility) • Test the surface infiltration rate using ASTM C1701 as a corrective maintenance indicator. Perform one test per installation, up to 2,500 square feet. Perform an additional test for each additional 2,500 square feet up to 15,000 square feet total. Above 15,000 square feet, add one test for every 10,000 square feet. • If the results indicate an infiltration rate of 10 inches per hour or less, then perform corrective main-

**Table V-4.5.2(22) Maintenance Standards - Permeable Pavement
(continued)**

Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				<p>tenance to restore permeability. To clean clogged pavement surfaces, use one or combination of the following methods:</p> <ul style="list-style-type: none"> ◦ Combined pressure wash and vacuum system calibrated to not dislodge wearing course aggregate. ◦ Hand held pressure washer or power washer with rotating brushes ◦ Pure vacuum sweepers <p>Note: If the annual/biannual routine maintenance standard to clean the pavement surface is conducted using equipment from the list above, corrective maintenance may not be needed.</p>
	A		Sediment present at the surface of the pavement	<ul style="list-style-type: none"> • Assess the overall performance of the pavement system during a rain event. If water runs off the pavement and/or there is ponding then see above. • Determine source of sediment loading and evaluate whether or not the source

**Table V-4.5.2(22) Maintenance Standards - Permeable Pavement
(continued)**

Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				can be reduced/eliminated. If the source cannot be addressed, consider increasing frequency of routine cleaning (e.g., twice per year instead of once per year).
	Summer		Moss growth inhibits infiltration or poses slip safety hazard	<ul style="list-style-type: none"> • Sidewalks: Use a stiff broom to remove moss in the summer when it is dry • Parking lots and roadways: Pressure wash, vacuum sweep, or use a combination of the two for cleaning moss from pavement surface. May require stiff broom or power brush in areas of heavy moss.
	A		Major cracks or trip hazards and concrete spalling and raveling	<ul style="list-style-type: none"> • Fill potholes or small cracks with patching mixes • Large cracks and settlement may require cutting and replacing the pavement section. Replace in-kind where feasible. Replacing porous asphalt with conventional asphalt is acceptable if it is a small percentage of the total facility area and does not impact the overall facility function. • Take appropriate pre-

**Table V-4.5.2(22) Maintenance Standards - Permeable Pavement
(continued)**

Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				cautions during pavement repair and replacement efforts to prevent clogging of adjacent porous materials
Interlocking concrete paver blocks and aggregate pavers		A or B	None (routine maintenance)	<p>Clean pavement surface using one or a combination of the following methods:</p> <ul style="list-style-type: none"> • Remove sediment, debris, trash, vegetation, and other debris deposited onto pavement (rakes and leaf blowers can be used for removing leaves) • Vacuum/sweep permeable paving installation using: <ul style="list-style-type: none"> ◦ Walk-behind vacuum (sidewalks) ◦ High efficiency regenerative air or vacuum sweeper (roadways, parking lots) ◦ ShopVac or brush brooms (small areas) <p>Note: Vacuum settings may have to be adjusted to prevent excess uptake of aggregate from paver openings or joints. Vacuum surface openings in dry weather to remove dry, encrusted sediment.</p>
	A _b		Surface is	<ul style="list-style-type: none"> • Review the overall per-

**Table V-4.5.2(22) Maintenance Standards - Permeable Pavement
(continued)**

Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
			clogged: Ponding on surface or water flows off the permeable pavement surface during a rain event (does not infiltrate)	<p>formance of the facility (note that small clogged areas may not reduce overall performance of facility)</p> <ul style="list-style-type: none"> • Test the surface infiltration rate using ASTM C1701 as a corrective maintenance indicator. Perform one test per installation, up to 2,500 square feet. Perform an additional test for each additional 2,500 square feet up to 15,000 square feet total. Above 15,000 square feet, add one test for every 10,000 square feet. • If the results indicate an infiltration rate of 10 inches per hour or less, then perform corrective maintenance to restore permeability. • Clogging is usually an issue in the upper 2 to 3 centimeters of aggregate. Remove the upper layer of encrusted sediment, and fines, and/or vegetation from openings and joints between the pavers by mechanical means and/or suction equipment (e.g., pure vacuum sweeper).

**Table V-4.5.2(22) Maintenance Standards - Permeable Pavement
(continued)**

Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
<div>b</div> <div>A</div>		<p>Sediment present at the surface of the pavement</p>	<ul style="list-style-type: none"> Assess the overall performance of the pavement system during a rain event. If water runs off the pavement and/or there is ponding, then see above. Determine source of sediment loading and evaluate whether or not the source can be 	

**Table V-4.5.2(22) Maintenance Standards - Permeable Pavement
(continued)**

Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
			reduced/-eliminated. If the source cannot be addressed, consider increasing frequency of routine cleaning (e.g., twice per year instead of once per year).	
Summer		Moss growth inhibits infiltration or poses slip safety hazard	<ul style="list-style-type: none"> Side-walks: Use a stiff broom to remove moss in the summer when it is dry 	

**Table V-4.5.2(22) Maintenance Standards - Permeable Pavement
(continued)**

Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
			<ul style="list-style-type: none"> Parking lots and roadways: Vacuum sweep or stiff broom/-power brush for cleaning moss from pavement surface 	
A		Paver block missing or damaged	Remove individual damaged paver blocks by hand and replace or repair per manufacturer's recommendations	
A		Loss of aggregate material between paver blocks	Refill per manufacturer's recommendations for interlocking paver sections	
A		Settlement of	May require	

**Table V-4.5.2(22) Maintenance Standards - Permeable Pavement
(continued)**

Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
		surface	resetting	
Open-celled paving grid with gravel		A or B	None (routine maintenance)	<ul style="list-style-type: none"> Remove sediment, debris, trash, vegetation, and other debris deposited onto pavement (rakes and leaf blowers can be used for removing leaves) Follow equipment manufacturer guidelines for cleaning surface.
	A _b		Aggregate is clogged: Ponding on surface or water flows off the permeable pavement surface during a rain event (does not infiltrate)	<ul style="list-style-type: none"> Use vacuum truck to remove and replace top course aggregate Replace aggregate in paving grid per manufacturer's recommendations
	A		Paving grid missing or damaged	<ul style="list-style-type: none"> Remove pins, pry up grid segments, and replace gravel Replace grid segments where three or more adjacent rings are broken or damaged Follow manufacturer guidelines for repairing surface.
	A		Settlement of surface	May require resetting
	A		Loss of	Replenish aggregate material by

**Table V-4.5.2(22) Maintenance Standards - Permeable Pavement
(continued)**

Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
			aggregate material in paving grid	spreading gravel with a rake (gravel level should be maintained at the same level as the plastic rings or no more than 1/4 inch above the top of rings). See manufacturer's recommendations.
		A	Weeds present	<ul style="list-style-type: none"> • Manually remove weeds • Presence of weeds may indicate that too many fines are present (refer to Actions Needed under "Aggregate is clogged" to address this issue)
Open-celled paving grid with grass		A or B	None (routine maintenance)	<ul style="list-style-type: none"> • Remove sediment, debris, trash, vegetation, and other debris deposited onto pavement (rakes and leaf blowers can be used for removing leaves) • Follow equipment manufacturer guidelines for cleaning surface.
	A _b		Aggregate is clogged: Ponding on surface or water flows off the permeable pavement surface during a rain event (does not infiltrate)	Rehabilitate per manufacturer's recommendations.

**Table V-4.5.2(22) Maintenance Standards - Permeable Pavement
(continued)**

Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
	A		Paving grid missing or damaged	<ul style="list-style-type: none"> Remove pins, pry up grid segments, and replace grass Replace grid segments where three or more adjacent rings are broken or damaged Follow manufacturer guidelines for repairing surface.
	A		Settlement of surface	May require resetting
	A		Poor grass coverage in paving grid	<ul style="list-style-type: none"> Restore growing medium, reseed or plant, aerate, and/or amend vegetated area as needed Traffic loading may be inhibiting grass growth; reconsider traffic loading if feasible
		As needed	None (routine maintenance)	Use a mulch mower to mow grass
		A	None (routine maintenance)	<ul style="list-style-type: none"> Sprinkle a thin layer of compost on top of grass surface (1/2" top dressing) and sweep it in Do not use fertilizer
		A	Weeds present	<ul style="list-style-type: none"> Manually remove weeds Mow, torch, or inoculate and replace with preferred vegetation
Inlets/Outlets/Pipes				
Inlet/outlet	A		Pipe is dam-	Repair/replace

**Table V-4.5.2(22) Maintenance Standards - Permeable Pavement
(continued)**

Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
pipe			aged	
	A		Pipe is clogged	Remove roots or debris
Underdrain pipe	Clean pipe as needed	Clean orifice at least biannually (may need more frequent cleaning during wet season)	Plant roots, sediment or debris reducing capacity of underdrain (may cause prolonged drawdown period)	<ul style="list-style-type: none"> • Jet clean or rotary cut debris/roots from underdrain(s) • If underdrains are equipped with a flow restrictor (e.g., orifice) to attenuate flows, the orifice must be cleaned regularly
Raised sub-surface overflow pipe	Clean pipe as needed	Clean orifice at least biannually (may need more frequent cleaning during wet season)	Plant roots, sediment or debris reducing capacity of underdrain	<ul style="list-style-type: none"> • Jet clean or rotary cut debris/roots from underdrain(s) • If underdrains are equipped with a flow restrictor (e.g., orifice) to attenuate flows, the orifice must be cleaned regularly
Outlet structure	A, S		Sediment, vegetation, or debris reducing capacity of outlet structure	<ul style="list-style-type: none"> • Clear the blockage • Identify the source of the blockage and take actions to prevent future blockages
Overflow	B		Native soil is exposed or other signs of erosion damage are present at discharge point	Repair erosion and stabilize surface

**Table V-4.5.2(22) Maintenance Standards - Permeable Pavement
(continued)**

Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Aggregate Storage Reservoir				
Observation port	A, S		Water remains in the storage aggregate longer than anticipated by design after the end of a storm	If immediate cause of extended ponding is not identified, schedule investigation of subsurface materials or other potential causes of system failure.
Vegetation				
Adjacent large shrubs or trees		As needed	Vegetation related fallout clogs or will potentially clog voids	<ul style="list-style-type: none">• Sweep leaf litter and sediment to prevent surface clogging and ponding• Prevent large root systems from damaging subsurface structural components
		Once in May and Once in September	Vegetation growing beyond facility edge onto sidewalks, paths, and street edge	Edging and trimming of planted areas to control groundcovers and shrubs from overreaching the sidewalks, paths and street edge improves appearance and reduces clogging of permeable pavements by leaf litter, mulch and soil.
Leaves, needles, and organic debris		In fall (October to December) after leaf drop (1-3 times, depending on canopy cover)	Accumulation of organic debris and leaf litter	Use leaf blower or vacuum to blow or remove leaves, evergreen needles, and debris (i.e., flowers, blossoms) off of and away from permeable pavement
Note that the inspection and routine maintenance frequencies listed above are recom-				

**Table V-4.5.2(22) Maintenance Standards - Permeable Pavement
(continued)**

Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
mended by Ecology. They do not supersede or replace the municipal stormwater permit requirements for inspection frequency required of municipal stormwater permittees for "stormwater treatment and flow control BMPs/facilities".				
a Frequency: A= Annually; B= Biannually (twice per year); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).				
b Inspection should occur during storm event.				

Appendix C: Catch Basin Inspection Procedure

Appendix C

Catch Basin Inspection Procedure

Catch basin inspections require two staff members. **Staff member one** is responsible for driving the vehicle, routing, and completing the Cityworks Inspection Forms. **Staff member two** is responsible for the visual inspection of the catch basin which includes probing the catch basin for sediment depth.

Upon arriving at a catch basin:

- **Staff Member one** activates the light bar and positions the vehicle next to the catch basin. Staff member one remains in the vehicle and prepares to record inspection observations.
- **Staff member two** exits the vehicle and removes the catch basin lid and reports observations to staff member one.
- **Staff member one** records the inspection observations.
- In the event of a structural failure **staff member one** exits the vehicle and documents the failure with photographs.
- In the event of a sediment failure **staff member one** spawns a vector sediment work order from the inspection form.
- **Staff member two** either re-enters the vehicle or walks to the next catch basin depending on the location of the next catch basin.

If a catch basin fails one or a combination of the structural observations, photos are taken and attached to the inspection template. One picture demonstrates an overview of the catch basin's location. Additional pictures are taken to document the failure/failures.

The following figures demonstrate the inspection form and the custom inspection observations. The custom inspection observations have been configured to reflect best management practices (BMPs) from the 2012 Stormwater Management Manual for Western Washington.

The sediment observation is pass/fail. If sediment is greater than 60 percent of the sump at the lowest invert, select fail. A sediment failure requires the creation of a vector sediment work order.

If the sediment is less than 60 percent of the sump at the lowest invert, select pass.

The screenshot shows a form titled "Sediment". At the top, there are two radio buttons: "FAIL" and "PASS". The "PASS" radio button is selected. Below the radio buttons is a blue box containing an information icon (i) and the text "< 60% at lowest invert".

If the top slab or frame slab connection has holes larger than 2 square inches or cracks wider than 1/4 inch, select fail.

The screenshot shows a form titled "Frame/Slab". At the top, there are three radio buttons: "FAIL", "CONCERN", and "PASS". The "FAIL" radio button is selected. Below the radio buttons is a blue box containing an information icon (i) and the text "Holes larger than 2 square inches or cracks larger than 1/4 inch".

If the top slab or frame slab connection has holes between 1 and 2 square inches or cracks greater than 1/8 inch and less than 1/4 inch, select concern.

The screenshot shows a form titled "Frame/Slab". At the top, there are three radio buttons: "FAIL", "CONCERN", and "PASS". The "CONCERN" radio button is selected. Below the radio buttons is a blue box containing an information icon (i) and the text "Holes between 1 and 2 inches or cracks greater than 1/8 inch and less than a 1/4 inch".

If the top slab or frame slab connection has holes less than 1 square inch or cracks less than 1/8 inch, select pass.

The screenshot shows a form titled "Frame/Slab". At the top, there are three radio buttons: "FAIL", "CONCERN", and "PASS". The "PASS" radio button is selected. Below the radio buttons is a blue box containing an information icon (i) and the text "No holes larger than 1 square inch and cracks larger than 1/8 inch".

If the structure is judged to be unsound, select fail.

The screenshot shows a form titled "Walls/Bottom". At the top, there are three radio buttons: "FAIL", "CONCERN", and "PASS". The "FAIL" radio button is selected. Below the radio buttons is a blue box containing an information icon (i) and the text "Judgment that structure is unsound and needs immediate repair or replacement; function of basin is severely compromised".

If the structure has structural issues but does not require immediate repair, select concern.

Walls/Bottom ☐ FAIL ☒ CONCERN ☐ PASS

i Judgement that there are structural issues but basin is functioning; may need minor repair

If the structure has no structural issues, select pass.

Walls/Bottom ☐ FAIL ☐ CONCERN ☒ PASS

i No structural issues; function of basin is sound

If the grout fillet has separated or cracked wider than 1/2 inch and longer than one foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering the catch basin through the cracks, select fail.

Grout Fillet (Pipe to Wall) ☒ FAIL ☐ CONCERN ☐ PASS

i Crack > 1/2inch and longer than 1 foot with evidence of sediment entering

If the grout fillet has separated or cracks between 1/4 inch and 1/2 inch and the length is less than one foot at the joint of any inlet/outlet pipe and there is no evidence of soil particles entering the catch basin through the cracks, select concern.

Grout Fillet (Pipe to Wall) ☐ FAIL ☒ CONCERN ☐ PASS

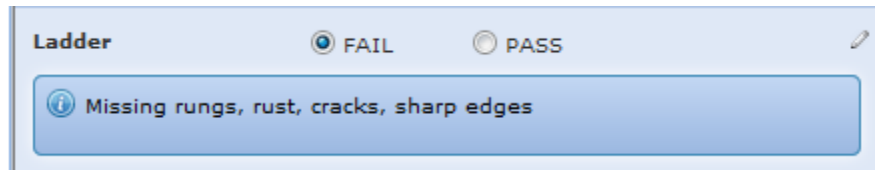
i Cracks between 1/4 inch and 1/2 inch and length less than one foot with no evidence of sediment entering

If the grout fillet has not separated or cracks less than 1/4 inch and a length less than one foot at the joint of any inlet/outlet pipe and there is no evidence of soil particles entering the catch basin through the cracks, pass.

Grout Fillet (Pipe to Wall) ☐ FAIL ☐ CONCERN ☒ PASS

i Crack < 1/4inch and less than 1 ft length with NO evidence of sediment entering

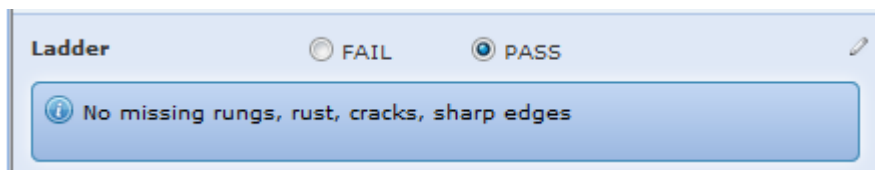
Ladders in type 2 catch basins are inspected to determine if they are safe. Conditions that warrant failure include: missing rungs, not attached securely, rust, or sharp edges.



Ladder ☒ FAIL ☐ PASS

Missing rungs, rust, cracks, sharp edges

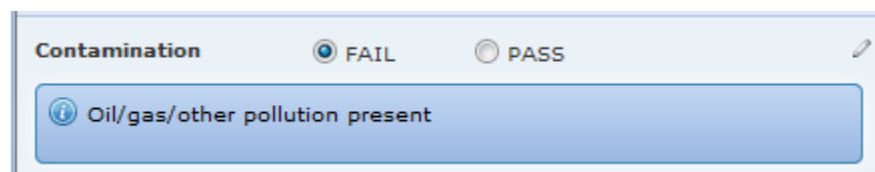
Conditions that warrant pass include: all rungs intact, attached securely, no rust, no cracks, and no sharp edges.



Ladder ☐ FAIL ☒ PASS

No missing rungs, rust, cracks, sharp edges

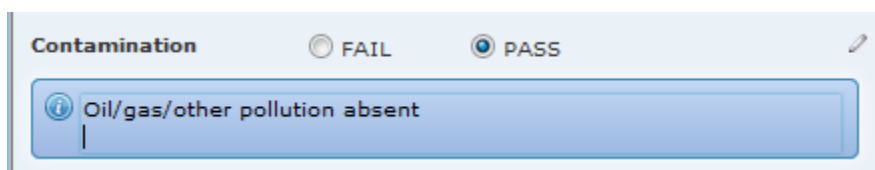
If contamination is detected either by site or smell, select fail.



Contamination ☒ FAIL ☐ PASS

Oil/gas/other pollution present

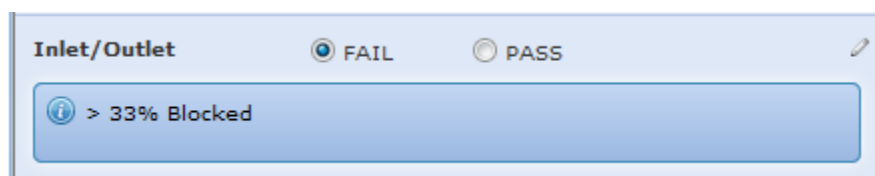
If contamination is not detected, select pass.



Contamination ☐ FAIL ☒ PASS

Oil/gas/other pollution absent

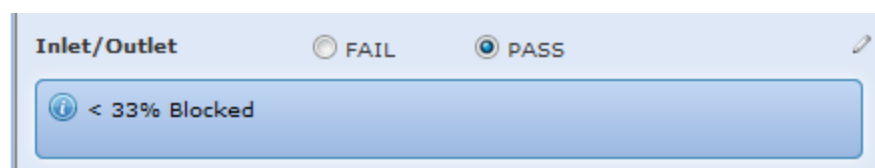
If the sediment is blocking 33 percent of the inlet or outlet, select fail.



Inlet/Outlet ☒ FAIL ☐ PASS

> 33% Blocked


If the sediment is not blocking 33 percent of the inlet or outlet, select pass.




Inlet/Outlet ☐ FAIL ☒ PASS


< 33% Blocked


If trash or debris exceeds 60 percent of the sump depth or is blocking the inlet, select fail.

Trash and Debris ☒ FAIL ☐ PASS 


 Blocking inlet, or >60% sump depth


If trash or debris is less than 60 percent of the sump depth and is not blocking the inlet, select pass.

Trash and Debris ☐ FAIL ☒ PASS 


 Not blocking inlet, and < 60% sump depth


If the catch basin cannot be located, select fail.

Cannot Locate ☒ FAIL ☐ PASS 


 Cannot locate


If the catch basin can be located, select pass.

Cannot Locate ☐ FAIL ☒ PASS 


 Can locate

Other can be used for any condition that is deemed unacceptable and is not covered by the other observation categories.

Other ☒ FAIL ☐ PASS 

 Other - comment

Lateral connection is used to identify unmapped lateral connections.

Lateral Connection ☒ Lateral ☐ Unknown ☐ Other 

The Comments section is used to provide additional information. For example, if a lateral connection is selected the following information should be gathered: pipe size, pipe material, and pipe orientation.

Comments	
Observation:	
Repairs:	
Recommendation:	
Cond. Score: 0	

Procedure for creating repair/replace work orders

After each month of catch basin inspections, inspection forms will be queried in order to determine which catch basins require repair or replacement. In order to create the maintenance work orders, eight Cityworks searches must be completed.

Cityworks Searches for Creating Maintenance Workorders
• Frame/Slab, Walls/Bottom, and Grout Fillet
• Frame/Slab, Walls/Bottom (Pass or Concern on Grout Fillet)
• Frame/Slab, Grout Fillet (Pass or Concern on Walls/Bottom)
• Walls/Bottom and Grout Fillet (Pass or Concern on Frame/Slab)
• Frame/Slab (Pass or Concern on Walls/Bottom and Grout Fillet)
• Walls Bottom (Pass or Concern on Frame/Slab and Grout Fillet)
• Grout Fillet (Pass or Concern on Frame/Slab and Walls Bottom)
• Total Work Orders/Assets

After completing each search, highlight the assets within Cityworks and create the appropriate work order. The six-month window for completing the work will begin once the work orders are created.

Appendix D: Ditch Maintenance Inspection Procedure

Appendix D

Ditch Maintenance Inspection Procedure

Ditch Inspections require one staff member. The staff member is responsible for driving the vehicle, routing, visual inspection, probing the ditch (as necessary), and completing the Cityworks Inspection Forms.

Upon arriving at a ditch:

- The staff member will activate the truck's light bar and position the vehicle next to the ditch.
- The staff member exits the vehicle and records inspection observations.
- In the event of a failure, the staff member will create a repair work order.

The following figures demonstrate the inspection form and the custom inspection observations. The custom inspection observations have been configured to reflect best management practices (BMPs) from the 2012 Stormwater Management Manual for Western Washington.

Inspection

Details

Id: 46079

Apply to All: ☐

Location:

Status: INITIATED

Resolution:

Insp. Date:

Inspected By:

Observations

Vegetation

☐ FAIL ☐ PASS

Contamination

☐ FAIL ☐ PASS

Trash and Debris

☐ FAIL ☐ PASS

Inlet/Outlet

☐ FAIL ☐ PASS

Sediment

☐ FAIL ☐ PASS

Erosion

☐ FAIL ☐ PASS

Flow Spreader

☐ FAIL ☐ PASS

Vegetation Condition

☐ Resident Maintained
☐ Not Maintained
☐ Vegetation Substantial
☐ Vegetation Minimal

Locates

☐ NO ☐ YES

Lateral Connection

☐ Lateral
☐ Unknown
☐ Other

Weir

☐ FAIL ☐ PASS

Cannot Locate

☐ FAIL ☐ PASS

Other

☐ FAIL ☐ PASS

Reset

Comments

Observation:

Repairs:

Recommendation:

Cond. Score: 0

Inspection

Details

Type: DITCH

Submit To:

Date:

Priority:

Initiated By: BERRINGTON, CHRISTOPHE

Initiated Date: 09/11/2017 2:46 PM

Projected Start: 09/11/2017 2:46 PM

Projected Finish:

Actual Finish:

Closed By:

Date Closed:

Cancel Insp? ☐

Cancel Date:

Cancel Reason:

Cancelled By:

Location

Shop:

Basin:

Maint Zone:

Neighborhood:

Map Layer Fields

Reset

Entity

Highlight

Get from Map

History

Remove

Asset Costs

Editable Fields: ☒

All Fields: ☐

SVDITCH

Id 0

Work Cycle

Repeat: Never

Interval: 0 Months

From: Actual Finish Date

Related Work Activities

Request:

Work Order:

Create Work Order:

Create

Inspections:

Parent:

Create Child Inspection

Attachments

+ Add attachments...

Remove all attachments

Drag and drop files here to attach them.

If vegetation is blocking the free movement of water, select fail.

Vegetation

☒ FAIL
☐ PASS

Blocking free movement of water

If vegetation is not blocking the free movement of water, select pass.

Vegetation

☐ FAIL ☒ PASS

i Not blocking free movement of water

If oil, gas, or other pollution is detected, select fail.

Contamination

☒ FAIL ☐ PASS

i Oil/gas/other pollution present

If oil, gas, or other pollution is not detected, select pass.

Contamination

☐ FAIL ☒ PASS

i Oil/gas/other pollution absent

If trash or debris is present, select fail.

Trash and Debris

☒ FAIL ☐ PASS

i Present

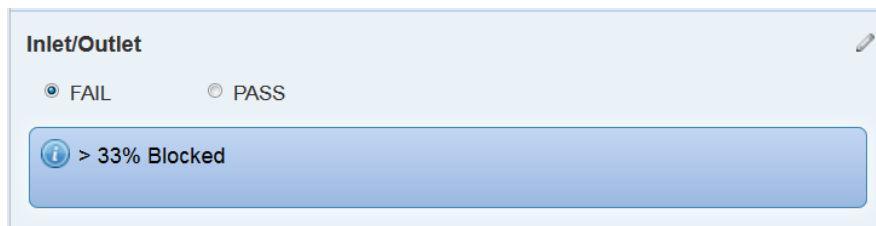
If trash or debris is absent, select pass.

Trash and Debris

☐ FAIL ☒ PASS

i Absent

If the inlet or outlet pipe is 33% blocked, select fail.

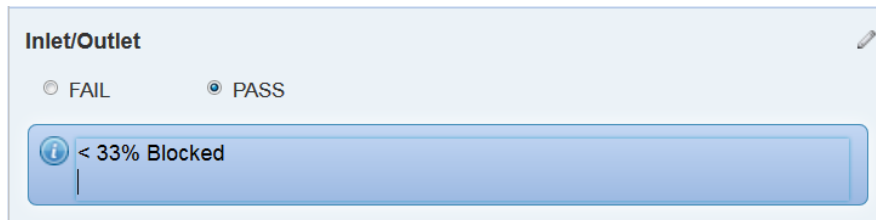


Inlet/Outlet

☒ FAIL ☐ PASS

> 33% Blocked

If the inlet or outlet pipe is not 33% blocked, select pass.

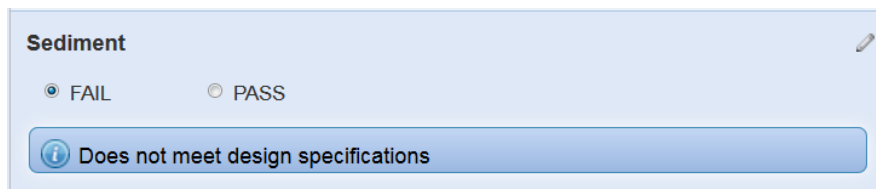


Inlet/Outlet

☐ FAIL ☒ PASS

< 33% Blocked

If sediment has accumulated and the ditch no longer conforms to design standards, select fail.

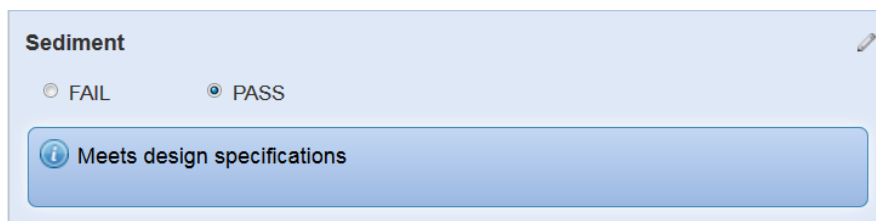


Sediment

☒ FAIL ☐ PASS

Does not meet design specifications

If sediment has not accumulated and the ditch conforms to design standards, select pass.

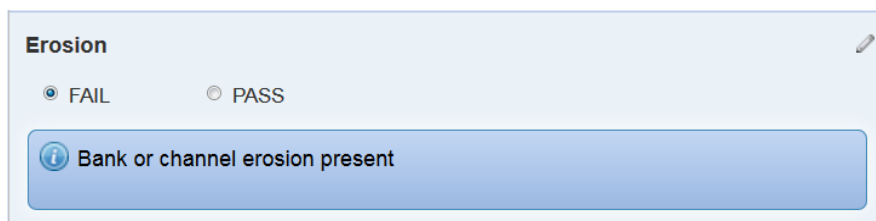


Sediment

☐ FAIL ☒ PASS

Meets design specifications

If bank or channel erosion is present, select fail.



Erosion

☒ FAIL ☐ PASS

Bank or channel erosion present

If bank or channel erosion is not present, select pass.

Erosion

☐ FAIL ☒ PASS

i Bank or channel erosion absent

If sheet flow cannot enter the ditch along the length of the ditch, select fail.

Flow Spreader

☒ FAIL ☐ PASS

i Flows are not evenly distributed

If sheet flow can enter the ditch along the length of the ditch, select fail.

Flow Spreader

☐ FAIL ☒ PASS

i Flows are evenly distributed

If it appears that the ditch vegetation is maintained by a local resident, select resident maintained.

Vegetation Condition

☒ Resident Maintained ☐ Not Maintained ☐ Vegetation Substantial
☐ Vegetation Minimal

i The ditch appears to be maintained by the adjacent property owner.

If it appears that the ditch vegetation is not maintained and it does not have any vegetation requiring maintenance, select not maintained.

Vegetation Condition

☐ Resident Maintained ☒ Not Maintained ☐ Vegetation Substantial
☐ Vegetation Minimal

i The ditch does not have vegetation requiring maintenance.

If the ditch vegetation is ≥ 24 inches but does not represent a safety or functional issue, select vegetation substantial.

Vegetation Condition

☐ Resident Maintained
 ☐ Not Maintained
 ☒ Vegetation Substantial
 ☐ Vegetation Minimal

i The ditch is overgrown, but this does not represent a safety or a functional issue. Vegetation 24 inches or higher.

If the ditch does not appear to be resident maintained and the vegetation is < 24 inches, select vegetation minimal.

Vegetation Condition

☐ Resident Maintained
 ☐ Not Maintained
 ☐ Vegetation Substantial
 ☒ Vegetation Minimal

i The ditch does not appear to be resident maintained, but the vegetation is minimal. Vegetation shorter than 24 inches.

If locates are not required select no. If locates are required select yes.

Locates

☐ NO
 ☐ YES

If a lateral connection is detected and it appears to come from a private residence, select lateral. If a lateral connection is detected, but the origin is unclear, select unknown. Other should be used for other situations that do not fall under lateral or unknown.

Lateral Connection

☐ Lateral
 ☐ Unknown
 ☐ Other
 ☐ N/A


If the ditch has a weir that is no longer intact, select fail.

Weir


☒ FAIL
 ☐ PASS

i Not intact


If the ditch has a weir that is intact, select pass.

Weir


☐ FAIL ☒ PASS

 Intact


If the ditch cannot be located, select fail.

Cannot Locate


☒ FAIL ☐ PASS

 Cannot locate


If the ditch can be located, select pass.

Cannot Locate

☐ FAIL ☒ PASS

 Can locate

If the ditch has a failure that is not covered with the other custom inspection observations, select fail and record the failure in the comments section of the inspection template.

Other

☐ FAIL ☐ PASS

Appendix E: Aqua-Filter: AquaSwirl Chamber and Filter Media Maintenance Guidance

Aqua-Filter™ / Maintenance Pretreatment Swirl Chamber

The pretreatment hydrodynamic separator (swirl chamber) has been designed to minimize and simplify the inspection and maintenance process. The single swirl chamber system can be inspected and maintained entirely from the surface thereby eliminating the need for confined space entry. There are no areas of the structure that are blocked from visual inspection or periodic cleaning. Inspection of any free-floating oil and floatable debris can be directly observed and maintained through the manhole access provided directly over the swirl chamber.

Swirl Chamber Inspection Procedure

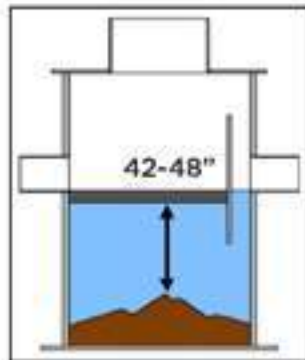
To inspect the pretreatment swirl chamber, a hook is needed to remove the manhole cover. AquaShield™ provides a customized manhole cover with our distinctive logo to make it easy for maintenance crews to locate a system in the field. We also provide a permanent metal information plate affixed inside the access riser which provides our contact information, the model size and serial number.

The only tools needed to inspect the swirl chamber are a flashlight and a measuring device such as a stadia rod or pole. Given the easy and direct accessibility provided, floating oil and debris can be observed directly from the surface. Sediment depths can easily be determined by lowering a measuring device to the top of the sediment pile and to the surface of the water.

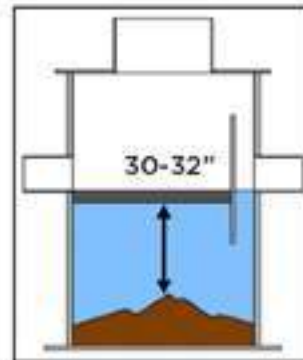
The maintenance trigger for 3.5 foot to 13 foot diameter swirl chambers occurs when the sediment pile is within 42 to 48 inches of the standing water surface. For the 2.5 foot diameter swirl chamber, maintenance is needed when the top of the sediment pile is measured to be 30 to 32 inches below the standing water surface.



Sediment inspection using a stadia rod in a single pretreatment chamber.



Maintenance trigger for 3.5 to 13 foot diameter swirl chamber occurs when sediment pile is 42-48 inches below water surface.



Maintenance trigger for 2.5 foot diameter swirl chamber occurs when sediment pile is 30-32 inches below water surface.

It should be noted that in order to avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the top of the sediment pile. Keep in mind that the finer sediment at the top of the pile may offer less resistance to the measuring device than the larger particles which typically occur deeper within the sediment pile.

The swirl chamber design allows for the sediment to accumulate in a semi-conical fashion as illustrated above. That is, the depth to sediment as measured below the water surface may be less in the center of the swirl chamber; and likewise, may be greater at the edges of the swirl chamber.

Swirl Chamber Cleanout Procedure

Cleaning the pretreatment swirl chamber is simple and quick. Free-floating oil and floatable debris can be observed and removed directly through the 30-inch service access riser provided. A vacuum truck is typically used to remove the accumulated sediment and debris. An advantage of the swirl chamber design is that the entire sediment storage area can be reached with a vacuum hose from the surface (reaching all the sides). Since there are no multiple or limited (hidden or "blind") chambers in the pretreatment hydrodynamic separator, there are no restrictions to impede on-site maintenance tasks.

Disposal of Recovered Materials from Swirl Chamber

Disposal of recovered material is typically handled in the same fashion as catch basin cleanouts. AquaShield™ recommends that all maintenance activities be performed in accordance with appropriate health and safety practices for the tasks and equipment being used. AquaShield™ also recommends that all materials removed from the swirl chamber and any external structures (e.g., bypass features) be handled and disposed in full accordance with any applicable local and state requirements.

Aqua-Filter™ / Maintenance Filter Chamber

The filter media is also easily observed from the surface. Manhole covers are spaced over the entire filtration bed to provide easy access. AquaShield™ provides a customized manhole cover with our logo to make it easy for maintenance crews to locate a system in the field. An entry riser provides direct access into the filtration chamber with a permanent ladder welded into the downstream section of the filtration chamber. This additional access allows for the vacuuming of any standing water and an unobstructed access to the downstream side of the filter bed.

Initially, perlite filter media is light tan or white in color. When the media color turns black or dark brown, it has become saturated due to pollutant loading and requires replacement. Call toll free (888) 344-9044 to order replacement filters.

Replacement of the filtration media typically requires entry into the filtration chamber by one of a two-member maintenance crew. Confined space entry methods should be followed by the maintenance crew when removing and replacing the filters. The spent filter containers are normally retrieved from the filter chamber by a second crewmember at the surface through the multiple 30-inch risers spaced across the top of the filter bed. In addition, the filter containers can be accessed directly from within the filtration chamber via a vertical removable panel (bulkhead door) at the rear of the filter bed and directly across from the ladder.

A permanent ingress/egress ladder provides access to filter chamber. Note metal product identification plate above ladder.



Aqua-Filter™ / Maintenance

Filter Media Disposal

Disposal of recovered material is typically handled in the same fashion as catch basin cleanouts. AquaShield™ recommends that all maintenance activities be performed in accordance with appropriate health and safety practices for the tasks and equipment being used. AquaShield™ also recommends that all materials removed from the pretreatment swirl chamber and any external structures (e.g. bypass features) be handled and disposed in full accordance with any applicable local and state requirements.



Spent filter media can often be recycled or sent to a permitted lined landfill. Always check local regulations to ensure proper disposal of spent filter media.

Filter Media Replacement

Instructions and photographs are provided on page 12 showing the procedures to follow to install fresh filter media containers. The bottom of two courses is placed on the fiberglass grates. Cargo netting is used across the top course of the filter containers to secure them in place.

Cargo Netting Installation

Cargo netting is used to secure filter containers in place after containers are installed in the appropriate orientation within the filtration chamber. Cargo netting is placed on top of the top course of filter containers and stretched into place using provided heavy duty cable ties. The netting is cable tied to anchor blocks and attached to the side walls of the filtration chamber. It is important to install the netting in such a way as to both cover the entire surface area of the containers while stretching netting snugly to minimize container movement under high flow conditions. Netting installation is complete when all surface area of filter containers are covered with netting and netting is secured with cable ties to anchor blocks.

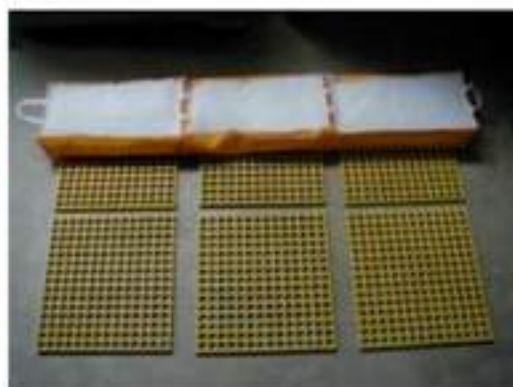


Aqua-Filter™ / Maintenance

Installation instructions for filter containers



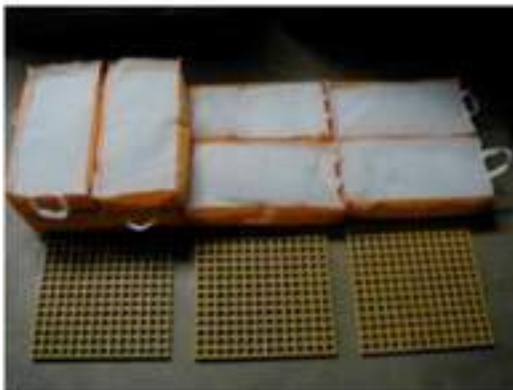
(1) Bottom Grates found in chamber



(2) First row first course



(3) Second row



(4) Second course started



(5) Second course complete

Aqua-Filter™ Inspection and Maintenance Manual Work Sheets

SITE & OWNER INFORMATION

Site Name: _____
 Site Location: _____
 Date: _____ Time: _____
 Inspector Name: _____
 Inspector Company: _____ Phone #: _____
 Owner Name: _____
 Owner Address: _____
 Owner Phone #: _____ Emergency #: _____

INSPECTION

Note: Aqua-Filter™ system is a treatment train including pretreatment hydrodynamic separator (swirl chamber) and filtration chamber.

I. Floatable Debris and Oil in Swirl Chamber

1. Remove manhole lid to expose liquid surface of the swirl chamber.
2. Remove floatable debris with basket or net if any present.
3. If oil is present, measure its depth. Clean liquids from system if one half (½) inch or more oil is present.

Note: Water in swirl chamber can appear black and similar to oil due to the dark body of the surrounding structure. Oil may appear darker than water in the system and is usually accompanied by oil stained debris (e.g. Styrofoam, etc.). The depth of oil can be measured with an oil/water interface probe, a stadia rod with water finding paste, a coliwasa, or collect a representative sample with a jar attached to a rod.

II. Sediment Accumulation in Swirl Chamber

1. Lower measuring device (e.g. stadia rod) into swirl chamber through service access provided until top of sediment pile is reached
2. Record distance to top of sediment pile from top of standing water: _____ inches
3. For swirl chambers 3.5 to 13 feet in diameter, schedule cleaning if value in Step #2 is 48 to 42 inches or less.
4. For swirl chamber 2.5 feet in diameter, schedule cleaning if value in Step #2 is 32 to 30 inches or less.

Aqua-Filter™ Inspection and Maintenance Manual Work Sheets

III. Filtration Chamber

1. Remove manhole lid(s) to expose filter media bed and access ingress/egress ladder. At a minimum, one manhole lid will be present to access ladder. Larger filtration chamber sizes may have one or more manhole lids to access filter media bed.
2. Enter filtration chamber via ladder or through access riser(s) over filter bed. **Note: Water may be present at minimal depths in the filtration chamber prior to clean-out during inspection.**
3. Remove bulkhead door (gate) at downstream end of filtration chamber and across from ladder (**Figure 1**).
4. Remove filter grate covers/cargo nets and filters through access risers located along filtration chamber length or through ingress/egress ladder manhole.
5. Visually inspect filter media noting color and saturation or contaminants.
6. If (perlite) media is dark brown or black, the media is fully spent and should be replaced (**Figure 2**).
7. Contact AquaShield™ for replacement filter media containers at (888) 344-9044, or info@aquashieldinc.com.
8. Schedule cleaning as described below.



Figure 1.
Removable bulkhead door across from ingress/egress ladder at rear of filtration chamber.



Figure 2.
Perlite filter media needs replacement.

IV. Diversion Structures (External Bypass Features)

Diversion (external bypass) structures should be inspected as follows:

1. Inspect weir or other bypass feature for structural decay or damage. Weirs are more susceptible to damage than off-set piping and should be checked to confirm that they are not crumbling (concrete or brick) or decaying (steel).
2. Inspect diversion structure and bypass piping for signs of structural damage or blockage from debris or sediment accumulation.
3. When feasible, measure elevations on diversion weir or piping to ensure it is consistent with site plan designs.
4. Inspect downstream (convergence) structure(s) for sign of blockage or structural failure as noted above.

Appendix F: Contech StormFilter Maintenance Guidelines



StormFilter Maintenance Guidelines

Maintenance requirements and frequency are dependent on the pollutant load characteristics of each site, and may be required in the event of a chemical spill or due to excessive sediment loading.

Maintenance Procedures

Although there are other effective maintenance options, CONTECH recommends the following two step procedure:

1. Inspection: Determine the need for maintenance.
2. Maintenance: Cartridge replacement and sediment removal.

Inspection and Maintenance Activity Timing

At least one scheduled inspection activity should take place per year with maintenance following as warranted.

First, inspection should be done before the winter season. During which, the need for maintenance should be determined and, if disposal during maintenance will be required, samples of the accumulated sediments and media should be obtained.

Second, if warranted, maintenance should be performed during periods of dry weather.

In addition, you should check the condition of the StormFilter unit after major storms for potential damage caused by high flows and for high sediment accumulation. It may be necessary to adjust the inspection/maintenance activity schedule depending on the actual operating conditions encountered by the system.

Generally, inspection activities can be conducted at any time, and maintenance should occur when flows into the system are unlikely.

Maintenance Activity Frequency

Maintenance is performed on an as needed basis, based on inspection. Average maintenance lifecycle is 1-3 years. The primary factor controlling timing of maintenance of the StormFilter is sediment loading. Until appropriate timeline is determined, use the following:

Inspection:

- One time per year
- After major storms

Maintenance:

- As needed
- Per regulatory requirement
- In the event of a chemical spill

Inspection Procedures

It is desirable to inspect during a storm to observe the relative flow through the filter cartridges. If the submerged cartridges are severely plugged, then typically large amounts of sediments will be present and very little flow will be discharged from the drainage pipes. If this is the case, then maintenance is warranted and the cartridges need to be replaced.

Warning: In the case of a spill, the worker should abort inspection activities until the proper guidance is obtained. Notify the local hazard control agency and CONTECH immediately.

To conduct an inspection:

72" StormFilter Manhole (Top Foods)

Important: Inspection should be performed by a person who is familiar with the StormFilter treatment unit.

1. If applicable, set up safety equipment to protect and notify surrounding vehicle and pedestrian traffic.
2. Visually inspect the external condition of the unit and take notes concerning defects/problems.
3. Open the access portals to the vault and allow the system vent.
4. Without entering the vault, visually inspect the inside of the unit, and note accumulations of liquids and solids.
5. Be sure to record the level of sediment build-up on the floor of the vault, in the forebay, and on top of the cartridges. If flow is occurring, note the flow of water per drainage pipe. Record all observations. Digital pictures are valuable for historical documentation.
6. Close and fasten the access portals.
7. Remove safety equipment.
8. If appropriate, make notes about the local drainage area relative to ongoing construction, erosion problems, or high loading of other materials to the system.
9. Discuss conditions that suggest maintenance and make decision as to weather or not maintenance is needed.

Maintenance Decision Tree

The need for maintenance is typically based on results of the inspection. Use the following as a general guide. (Other factors, such as regulatory requirements, may need to be considered)

1. Sediment loading on the vault floor. If $>4"$ of accumulated sediment, then go to maintenance.
2. Sediment loading on top of the cartridge. If $>1/4"$ of accumulation, then go to maintenance.
3. Submerged cartridges. If $>4"$ of static water in the cartridge bay for more that 24 hrs after end of rain event, then go to maintenance.
4. Plugged media. If pore space between media granules is absent, then go to maintenance.
5. Bypass condition. If inspection is conducted during an average rain fall event and StormFilter remains in bypass condition (water over the internal outlet baffle wall or submerged cartridges), then go to maintenance.
6. Hazardous material release. If hazardous material release (automotive fluids or other) is reported, then go to maintenance.
7. Pronounced scum line. If pronounced scum line (say $\geq 1/4"$ thick) is present above top cap, then go to maintenance.
8. Calendar Lifecycle. If system has not been maintained for 3 years, then go to maintenance.

Assumptions:

No rainfall for 24 hours or more.

No upstream detention (at least not draining into StormFilter).

Structure is online. Outlet pipe is clear of obstruction. Construction bypass is plugged.

Maintenance

Depending on the configuration of the particular system, workers will be required to enter the vault to perform the maintenance.

Important: If vault entry is required, OSHA rules for confined space entry must be followed.

Filter cartridge replacement should occur during dry weather. It may be necessary to plug the filter inlet pipe if base flow is occurring.

Replacement cartridges can be delivered to the site or customers facility. Contact CONTECH for more information.

Warning: In the case of a spill, the worker should abort maintenance activities until the proper guidance is obtained. Notify the local hazard control agency and CONTECH immediately.

To conduct cartridge replacement and sediment removal:

1. If applicable, set up safety equipment to protect workers and pedestrians from site hazards.
2. Visually inspect the external condition of the unit and take notes concerning defects/problems.
3. Open the doors (access portals) to the vault and allow the system to vent.
4. Without entering the vault, give the inside of the unit, including components, a general condition inspection.
5. Make notes about the external and internal condition of the vault. Give particular attention to recording the level of sediment build-up on the floor of the vault, in the forebay, and on top of the internal components.
6. Using appropriate equipment offload the replacement cartridges (up to 150 lbs. each) and set aside.
7. Remove used cartridges from the vault using one of the following methods:

Method 1:

- A. This activity will require that workers enter the vault to remove the cartridges from the under drain manifold and place them under the vault opening for lifting (removal). Unscrew (counterclockwise rotations) each filter cartridge from the underdrain connector. Roll the loose cartridge, on edge, to a convenient spot beneath the vault access.

Using appropriate hoisting equipment, attach a cable from the boom, crane, or tripod to the loose cartridge. Contact CONTECH for suggested attachment devices.

Important: Cartridges containing leaf media (CSF) do not require unscrewing from their connectors. Do not damage the manifold connectors. They should remain installed in the manifold and can be capped during the maintenance activity to prevent sediments from entering the under drain manifold.

- B. Remove the used cartridges (up to 250 lbs.) from the vault.

Important: Avoid damaging the cartridges during removal and installation.

- C. Set the used cartridge aside or load onto the hauling truck.
- D. Continue steps A through C until all cartridges have been removed.

Method 2:

- A. Enter the vault using appropriate confined space protocols.
- B. Unscrew the cartridge cap.
- C. Remove the cartridge hood screws (3) hood and float.
- D. At location under structure access, tip the cartridge on its side.

Important: Note that cartridges containing media other than the leaf media require unscrewing from their threaded connectors. Take care not to damage the manifold connectors. This connector should remain installed in the manifold and capped if necessary.

- E. Empty the cartridge onto the vault floor. Reassemble the empty cartridge.
- F. Set the empty, used cartridge aside or load onto the hauling truck.
- G. Continue steps A through E until all cartridges have been removed.

8. Remove accumulated sediment from the floor of the vault and from the forebay. Use vacuum truck for highest effectiveness.
9. Once the sediments are removed, assess the condition of the vault and the connectors. The connectors are short sections of 2-inch schedule 40 PVC, or threaded schedule 80 PVC that should protrude about 1" above the floor of the vault. Lightly wash down the vault interior.
 - a. If desired, apply a light coating of FDA approved silicon lube to the outside of the exposed portion of the connectors. This ensures a watertight connection between the cartridge and the drainage pipe.
 - b. Replace any damaged connectors.
10. Using the vacuum truck boom, crane, or tripod, lower and install the new cartridges. Take care not to damage connections.
11. Close and fasten the door.
12. Remove safety equipment.
13. Finally, dispose of the accumulated materials in accordance with applicable regulations. Make arrangements to return the used empty cartridges to CONTECH.

Material Disposal

The accumulated sediment must be handled and disposed of in accordance with regulatory protocols. It is possible for sediments to contain measurable concentrations of heavy metals and organic chemicals. Areas with the greatest potential for high pollutant loading include industrial areas and heavily traveled roads.

Sediments and water must be disposed of in accordance with applicable waste disposal regulations. Coordinate disposal of solids and liquids as part of your maintenance procedure. Contact the local public works department to inquire how they dispose of their street waste residuals.

Appendix G: Filterra Maintenance Guidelines

Filterra® Maintenance Steps



1. Inspection of Filterra and surrounding area



2. Removal of tree grate and erosion control stones



3. Removal of debris, trash and mulch



4. Mulch replacement



5. Clean area around Filterra



6. Complete paperwork and record plant height and width

Contech has created a network of Certified Maintenance Providers (CCMP's) to provide maintenance on Filterra systems. To find a CCMP in your area please visit www.conteches.com/maintenance

Appendix H: Contech CDS Maintenance Guidelines

CDS Guide

Operation, Design, Performance and Maintenance



CDS®

Using patented continuous deflective separation technology, the CDS system screens, separates and traps debris, sediment, and oil and grease from stormwater runoff. The indirect screening capability of the system allows for 100% removal of floatables and neutrally buoyant material without blinding. Flow and screening controls physically separate captured solids, and minimize the re-suspension and release of previously trapped pollutants. Inline units can treat up to 6 cfs, and internally bypass flows in excess of 50 cfs (1416 L/s). Available precast or cast-in-place, offline units can treat flows from 1 to 300 cfs (28.3 to 8495 L/s). The pollutant removal capacity of the CDS system has been proven in lab and field testing.

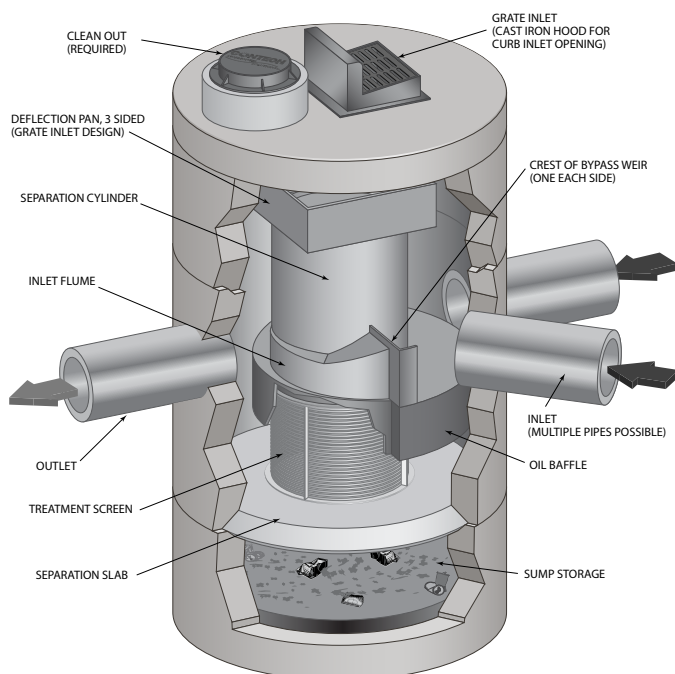
Operation Overview

Stormwater enters the diversion chamber where the diversion weir guides the flow into the unit's separation chamber and pollutants are removed from the flow. All flows up to the system's treatment design capacity enter the separation chamber and are treated.

Swirl concentration and screen deflection force floatables and solids to the center of the separation chamber where 100% of floatables and neutrally buoyant debris larger than the screen apertures are trapped.

Stormwater then moves through the separation screen, under the oil baffle and exits the system. The separation screen remains clog free due to continuous deflection.

During the flow events exceeding the treatment design capacity, the diversion weir bypasses excessive flows around the separation chamber, so captured pollutants are retained in the separation cylinder.



Design Basics

There are three primary methods of sizing a CDS system. The Water Quality Flow Rate Method determines which model size provides the desired removal efficiency at a given flow rate for a defined particle size. The Rational Rainfall Method™ or the Probabilistic Method is used when a specific removal efficiency of the net annual sediment load is required.

Typically in the United States, CDS systems are designed to achieve an 80% annual solids load reduction based on lab generated performance curves for a gradation with an average particle size (d50) of 125 microns (μm). For some regulatory environments, CDS systems can also be designed to achieve an 80% annual solids load reduction based on an average particle size (d50) of 75 microns (μm) or 50 microns (μm).

Water Quality Flow Rate Method

In some cases, regulations require that a specific treatment rate, often referred to as the water quality design flow (WQQ), be treated. This WQQ represents the peak flow rate from either an event with a specific recurrence interval, e.g. the six-month storm, or a water quality depth, e.g. 1/2-inch (13 mm) of rainfall.

The CDS is designed to treat all flows up to the WQQ. At influent rates higher than the WQQ, the diversion weir will direct most flow exceeding the WQQ around the separation chamber. This allows removal efficiency to remain relatively constant in the separation chamber and eliminates the risk of washout during bypass flows regardless of influent flow rates.

Treatment flow rates are defined as the rate at which the CDS will remove a specific gradation of sediment at a specific removal efficiency. Therefore the treatment flow rate is variable, based on the gradation and removal efficiency specified by the design engineer.

Rational Rainfall Method™

Differences in local climate, topography and scale make every site hydraulically unique. It is important to take these factors into consideration when estimating the long-term performance of any stormwater treatment system. The Rational Rainfall Method combines site-specific information with laboratory generated performance data, and local historical precipitation records to estimate removal efficiencies as accurately as possible.

Short duration rain gauge records from across the United States and Canada were analyzed to determine the percent of the total annual rainfall that fell at a range of intensities. US stations' depths were totaled every 15 minutes, or hourly, and recorded in 0.01-inch increments. Depths were recorded hourly with 1-mm resolution at Canadian stations. One trend was consistent at all sites; the vast majority of precipitation fell at low intensities and high intensity storms contributed relatively little to the total annual depth.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Rainfall Method. Since most sites are relatively small and highly impervious, the Rational Rainfall Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS system are

determined. Performance efficiency curve determined from full scale laboratory tests on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

Probabilistic Rational Method

The Probabilistic Rational Method is a sizing program Contech developed to estimate a net annual sediment load reduction for a particular CDS model based on site size, site runoff coefficient, regional rainfall intensity distribution, and anticipated pollutant characteristics.

The Probabilistic Method is an extension of the Rational Method used to estimate peak discharge rates generated by storm events of varying statistical return frequencies (e.g. 2-year storm event). Under the Rational Method, an adjustment factor is used to adjust the runoff coefficient estimated for the 10-year event, correlating a known hydrologic parameter with the target storm event. The rainfall intensities vary depending on the return frequency of the storm event under consideration. In general, these two frequency dependent parameters (rainfall intensity and runoff coefficient) increase as the return frequency increases while the drainage area remains constant.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Method. Since most sites are relatively small and highly impervious, the Rational Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS are determined. Performance efficiency curve on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

Treatment Flow Rate

The inlet throat area is sized to ensure that the WQQ passes through the separation chamber at a water surface elevation equal to the crest of the diversion weir. The diversion weir bypasses excessive flows around the separation chamber, thus preventing re-suspension or re-entrainment of previously captured particles.

Hydraulic Capacity

The hydraulic capacity of a CDS system is determined by the length and height of the diversion weir and by the maximum allowable head in the system. Typical configurations allow hydraulic capacities of up to ten times the treatment flow rate. The crest of the diversion weir may be lowered and the inlet throat may be widened to increase the capacity of the system at a given water surface elevation. The unit is designed to meet project specific hydraulic requirements.

Performance

Full-Scale Laboratory Test Results

A full-scale CDS system (Model CDS2020-5B) was tested at the facility of University of Florida, Gainesville, FL. This CDS unit was evaluated under controlled laboratory conditions of influent flow rate and addition of sediment.

Two different gradations of silica sand material (UF Sediment & OK-110) were used in the CDS performance evaluation. The particle size distributions (PSDs) of the test materials were analyzed using standard method "Gradation ASTM D-422 "Standard Test Method for Particle-Size Analysis of Soils" by a certified laboratory.

UF Sediment is a mixture of three different products produced by the U.S. Silica Company: "Sil-Co-Sil 106", "#1 DRY" and "20/40 Oil Frac". Particle size distribution analysis shows that the UF Sediment has a very fine gradation ($d_{50} = 20$ to $30 \mu\text{m}$) covering a wide size range (Coefficient of Uniformity, C_u averaged at 10.6). In comparison with the hypothetical TSS gradation specified in the NJDEP (New Jersey Department of Environmental Protection) and NJCAT (New Jersey Corporation for Advanced Technology) protocol for lab testing, the UF Sediment covers a similar range of particle size but with a finer d_{50} (d_{50} for NJDEP is approximately $50 \mu\text{m}$) (NJDEP, 2003).

The OK-110 silica sand is a commercial product of U.S. Silica Sand. The particle size distribution analysis of this material, also included in Figure 1, shows that 99.9% of the OK-110 sand is finer than 250 microns, with a mean particle size (d_{50}) of 106 microns. The PSDs for the test material are shown in Figure 1.

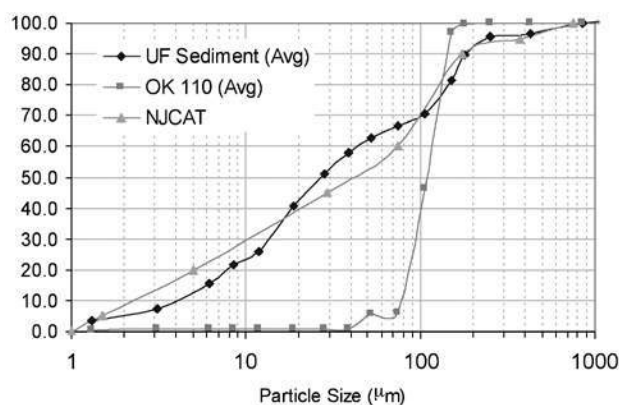


Figure 1. Particle size distributions

Tests were conducted to quantify the performance of a specific CDS unit (1.1 cfs (31.3-L/s) design capacity) at various flow rates, ranging from 1% up to 125% of the treatment design capacity of the unit, using the 2400 micron screen. All tests were conducted with controlled influent concentrations of approximately 200 mg/L. Effluent samples were taken at equal time intervals across the entire duration of each test run. These samples were then processed with a Dekaport Cone sample splitter to obtain representative sub-samples for Suspended Sediment Concentration (SSC) testing using ASTM D3977-97 "Standard Test Methods for Determining Sediment Concentration in Water Samples", and particle size distribution analysis.

Results and Modeling

Based on the data from the University of Florida, a performance model was developed for the CDS system. A regression analysis was used to develop a fitting curve representative of the scattered data points at various design flow rates. This model, which demonstrated good agreement with the laboratory data, can then be used to predict CDS system performance with respect

to SSC removal for any particle size gradation, assuming the particles are inorganic sandy-silt. Figure 2 shows CDS predictive performance for two typical particle size gradations (NJCAT gradation and OK-110 sand) as a function of operating rate.

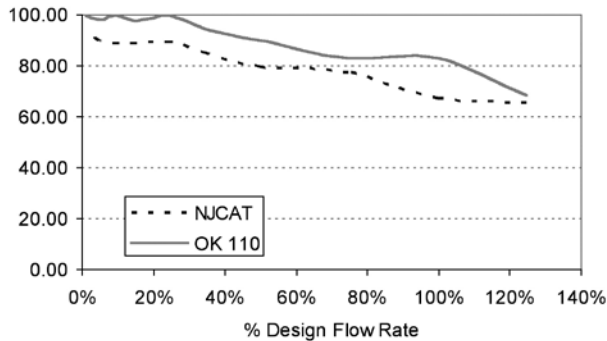


Figure 2. CDS stormwater treatment predictive performance for various particle gradations as a function of operating rate.

Many regulatory jurisdictions set a performance standard for hydrodynamic devices by stating that the devices shall be capable of achieving an 80% removal efficiency for particles having a mean particle size (d50) of 125 microns (e.g. Washington State Department of Ecology — WASDOE - 2008). The model can be used to calculate the expected performance of such a PSD (shown in Figure 3). The model indicates (Figure 4) that the CDS system with 2400 micron screen achieves approximately 80% removal at the design (100%) flow rate, for this particle size distribution (d50 = 125 μ m).

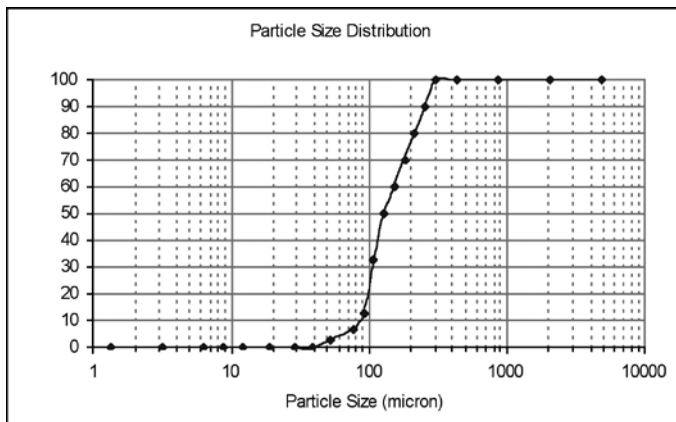


Figure 3. WASDOE PSD

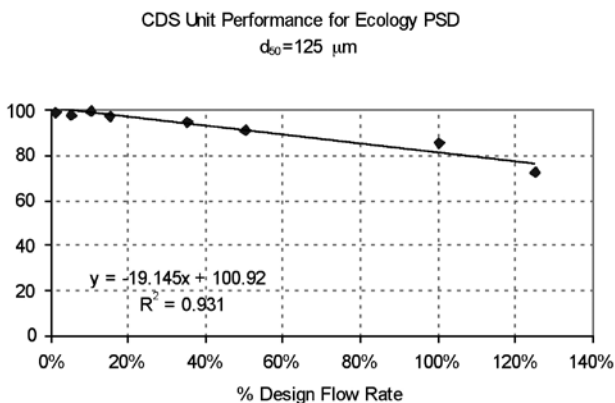


Figure 4. Modeled performance for WASDOE PSD.

Maintenance

The CDS system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit. For example, unstable soils or heavy winter sanding will cause the grit chamber to fill more quickly but regular sweeping of paved surfaces will slow accumulation.

Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant transport and deposition may vary from year to year and regular inspections will help ensure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (e.g. spring and fall) however more frequent inspections may be necessary in climates where winter sanding operations may lead to rapid accumulations, or in equipment washdown areas. Installations should also be inspected more frequently where excessive amounts of trash are expected.

The visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions in the inlet and separation screen. The inspection should also quantify the accumulation of hydrocarbons, trash, and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick, tape measure or other measuring instrument. If absorbent material is used for enhanced removal of hydrocarbons, the level of discoloration of the sorbent material should also be identified



during inspection. It is useful and often required as part of an operating permit to keep a record of each inspection. A simple form for doing so is provided.

Access to the CDS unit is typically achieved through two manhole access covers. One opening allows for inspection and cleanout of the separation chamber (cylinder and screen) and isolated sump. The other allows for inspection and cleanout of sediment captured and retained outside the screen. For deep units, a single manhole access point would allow both sump cleanout and access outside the screen.

The CDS system should be cleaned when the level of sediment has reached 75% of capacity in the isolated sump or when an appreciable level of hydrocarbons and trash has accumulated. If absorbent material is used, it should be replaced when significant discoloration has occurred. Performance will not be impacted until 100% of the sump capacity is exceeded; however, it is recommended that the system be cleaned prior to that for easier removal of sediment. The level of sediment is easily determined by measuring from finished grade down to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Particles at the top of the pile typically offer less resistance to the end of the rod than consolidated particles toward the bottom of the pile. Once this measurement is recorded, it should be compared to the as-built drawing for the unit to determine whether the height of the sediment pile off the bottom of the sump floor exceeds 75% of the total height of isolated sump.

Cleaning

Cleaning of a CDS system should be done during dry weather conditions when no flow is entering the system. The use of a vacuum truck is generally the most effective and convenient method of removing pollutants from the system. Simply remove the manhole covers and insert the vacuum hose into the sump. The system should be completely drained down and the sump fully evacuated of sediment. The area outside the screen should also be cleaned out if pollutant build-up exists in this area.

In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, the system should be cleaned out immediately in the event of an oil or gasoline spill. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use absorbent pads since they are usually less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Trash and debris can be netted out to separate it from the other pollutants. The screen should be cleaned to ensure it is free of trash and debris.

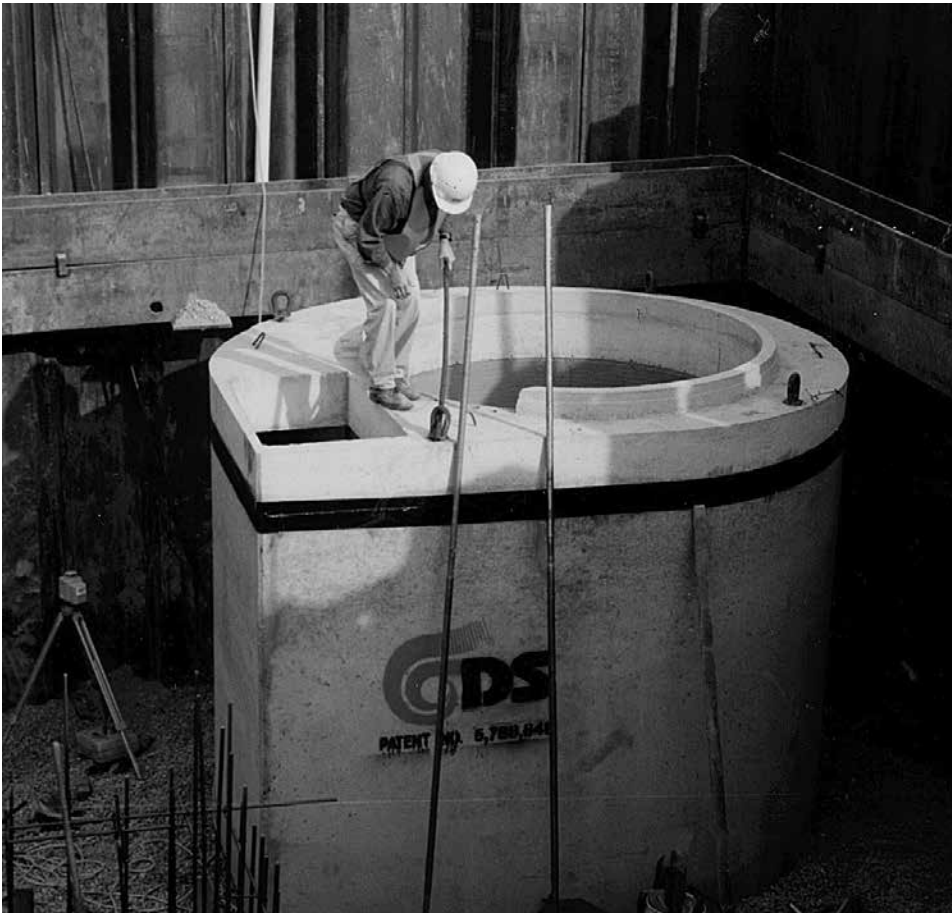
Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure that proper safety precautions have been followed. Confined space entry procedures need to be followed if physical access is required. Disposal of all material removed from the CDS system should be done in accordance with local regulations. In many jurisdictions, disposal of the sediments may be handled in the same manner as the disposal of sediments removed from catch basins or deep sump manholes. Check your local regulations for specific requirements on disposal.



CDS Model	Diameter		Distance from Water Surface to Top of Sediment Pile		Sediment Storage Capacity	
	ft	m	ft	m	y ³	m ³
CDS1515	3	0.9	3.0	0.9	0.5	0.4
CDS2015	4	1.2	3.0	0.9	0.9	0.7
CDS2015	5	1.5	3.0	0.9	1.3	1.0
CDS2020	5	1.5	3.5	1.1	1.3	1.0
CDS2025	5	1.5	4.0	1.2	1.3	1.0
CDS3020	6	1.8	4.0	1.2	2.1	1.6
CDS3025	6	1.8	4.0	1.2	2.1	1.6
CDS3030	6	1.8	4.6	1.4	2.1	1.6
CDS3035	6	1.8	5.0	1.5	2.1	1.6
CDS4030	8	2.4	4.6	1.4	5.6	4.3
CDS4040	8	2.4	5.7	1.7	5.6	4.3
CDS4045	8	2.4	6.2	1.9	5.6	4.3
CDS5640	10	3.0	6.3	1.9	8.7	6.7
CDS5653	10	3.0	7.7	2.3	8.7	6.7
CDS5668	10	3.0	9.3	2.8	8.7	6.7
CDS5678	10	3.0	10.3	3.1	8.7	6.7

Table 1: CDS Maintenance Indicators and Sediment Storage Capacities

Note: To avoid underestimating the volume of sediment in the chamber, carefully lower the measuring device to the top of the sediment pile. Finer silty particles at the top of the pile may be more difficult to feel with a measuring stick. These finer particles typically offer less resistance to the end of the rod than larger particles toward the bottom of the pile.



CDS Inspection & Maintenance Log

CDS Model: _____ Location: _____

[illegible]

1. The water depth to sediment is determined by taking two measurements with a stadia rod: one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the water surface. If the difference between these measurements is less than the values listed in table 1 the system should be cleaned out. **Note: to avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the top of the sediment pile.**
2. For optimum performance, the system should be cleaned out when the floating hydrocarbon layer accumulates to an appreciable thickness. In the event of an oil spill, the system should be cleaned immediately.

SUPPORT

- Drawings and specifications are available at www.ContechES.com.
- Site-specific design support is available from our engineers.



800-338-1122
www.ContechES.com

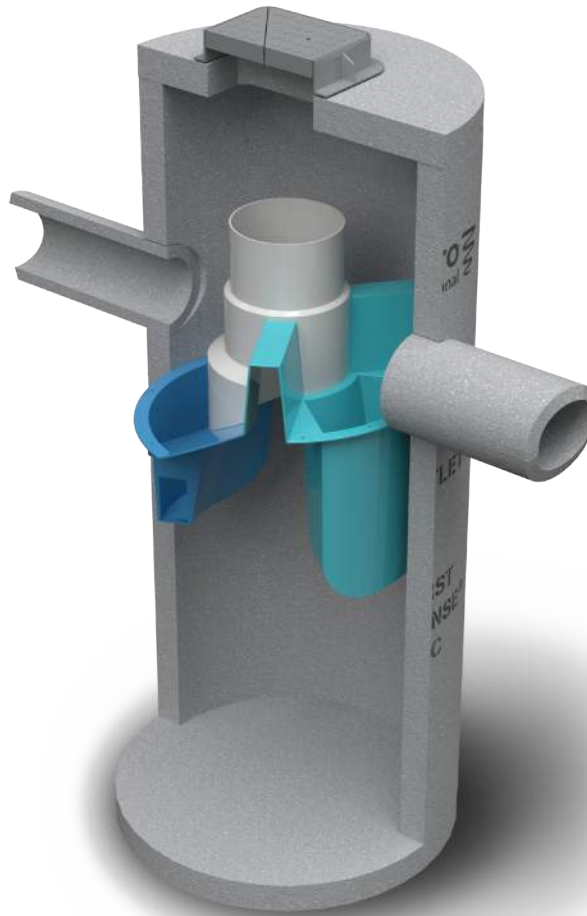
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Appendix I: First Defense Hydro International Maintenance Guidelines



Operation and Maintenance Manual

First Defense® and First Defense® High Capacity

Vortex Separator for Stormwater Treatment

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DISCLAIMER: Information and data contained in this manual is exclusively for the purpose of assisting in the operation and maintenance of Hydro International plc’s First Defense®. No warranty is given nor can liability be accepted for use of this information for any other purpose. Hydro International plc has a policy of continuous product development and reserves the right to amend specifications without notice.

I. First Defense® by Hydro International

Introduction

The First Defense® is an enhanced vortex separator that combines an effective and economical stormwater treatment chamber with an integral peak flow bypass. It efficiently removes total suspended solids (TSS), trash and hydrocarbons from stormwater runoff without washing out previously captured pollutants. The First Defense® is available in several model configurations (refer to *Section II. Model Sizes & Configurations*, page 4) to accommodate a wide range of pipe sizes, peak flows and depth constraints.

Operation

The First Defense® operates on simple fluid hydraulics. It is self-activating, has no moving parts, no external power requirement and is fabricated with durable non-corrosive components. No manual procedures are required to operate the unit and maintenance is limited to monitoring accumulations of stored pollutants and periodic clean-outs. The First Defense® has been designed to allow for easy and safe access for inspection, monitoring and clean-out procedures. Neither entry into the unit nor removal of the internal components is necessary for maintenance, thus safety concerns related to confined-space-entry are avoided.

Pollutant Capture and Retention

The internal components of the First Defense® have been designed to optimize pollutant capture. Sediment is captured and retained in the base of the unit, while oil and floatables are stored on the water surface in the inner volume (Fig.1).

The pollutant storage volumes are isolated from the built-in bypass chamber to prevent washout during high-flow storm events. The sump of the First Defense® retains a standing water level between storm events. This ensures a quiescent flow regime at the onset of a storm, preventing resuspension and washout of pollutants captured during previous events.

Accessories such as oil absorbent pads are available for enhanced oil removal and storage. Due to the separation of the oil and floatable storage volume from the outlet, the potential for washout of stored pollutants between clean-outs is minimized.

Applications

- Stormwater treatment at the point of entry into the drainage line
- Sites constrained by space, topography or drainage profiles with limited slope and depth of cover
- Retrofit installations where stormwater treatment is placed on or tied into an existing storm drain line
- Pretreatment for filters, infiltration and storage

Advantages

- Inlet options include surface grate or multiple inlet pipes
- Integral high capacity bypass conveys large peak flows without the need for “offline” arrangements using separate junction manholes
- Proven to prevent pollutant washout at up to 500% of its treatment flow
- Long flow path through the device ensures a long residence time within the treatment chamber, enhancing pollutant settling
- Delivered to site pre-assembled and ready for installation

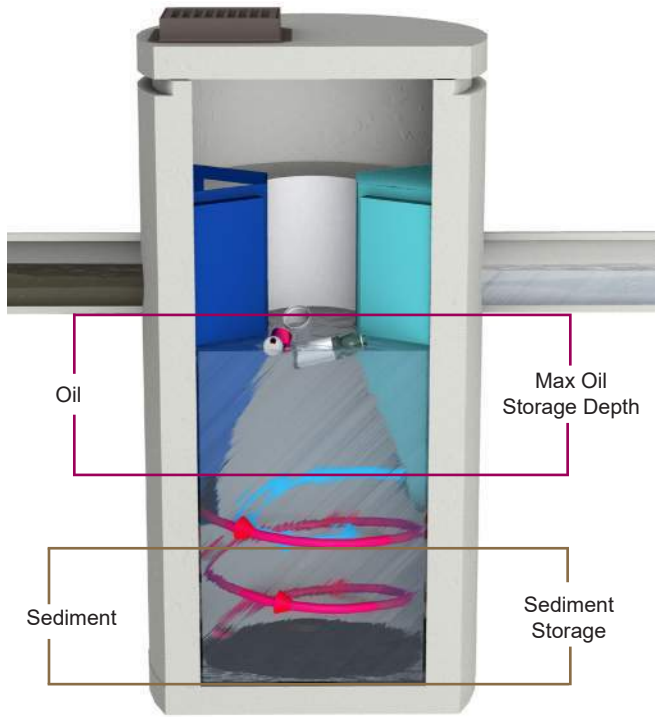


Fig.1 Pollutant storage volumes in the First Defense®.

II. Model Sizes & Configurations

The First Defense® inlet and internal bypass arrangements are available in several model sizes and configurations. The components of the First Defense®-4HC and First Defense®-6HC have modified geometries as to allow greater design flexibility needed to accommodate various site constraints.

All First Defense® models include the internal components that are designed to remove and retain total suspended solids (TSS), gross solids, floatable trash and hydrocarbons (Fig.2a - 2b). First Defense® model parameters and design criteria are shown in Table 1.

First Defense® Components

1. Built-In Bypass

2. Inlet Pipe

3. Inlet Chute
4. Floatables Draw-off Port

5. Outlet Pipe

6. Floatables Storage
7. Sediment Storage

8. Inlet Grate or Cover

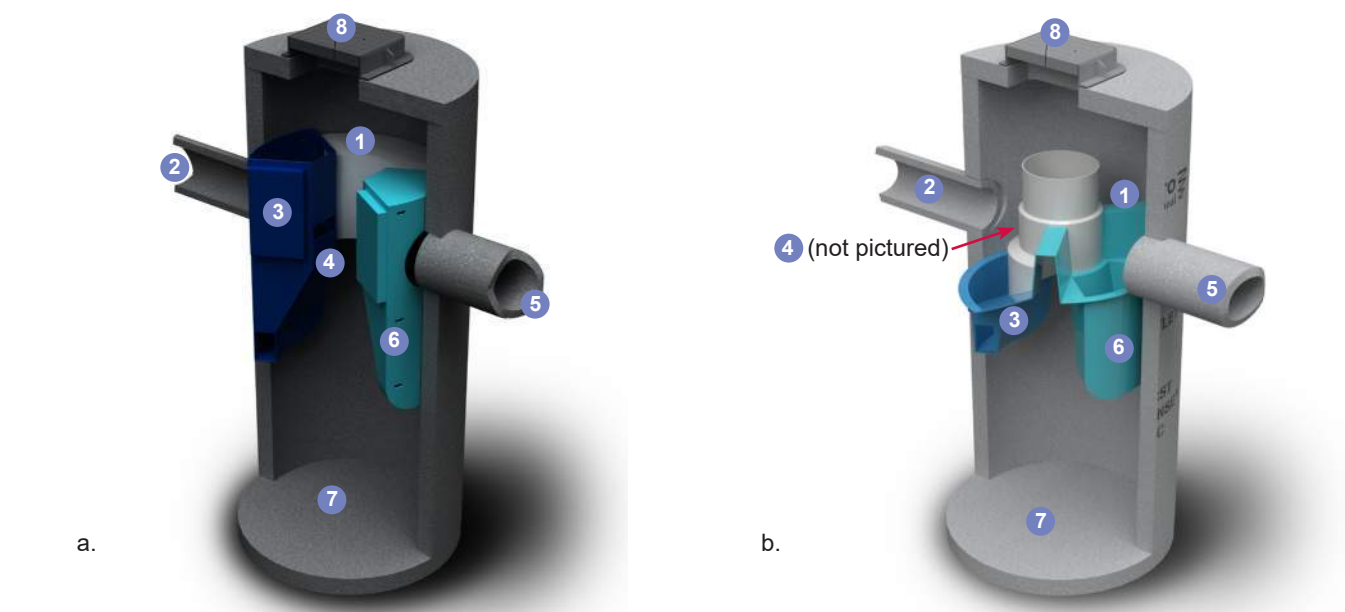


Fig.2a) First Defense®-4 and First Defense®-6; b) First Defense®-4HC and First Defense®-6HC, with higher capacity dual internal bypass and larger maximum pipe diameter.

First Defense® High Capacity Model Number	Diameter	Typical TSS Treatment Flow Rates	Peak Online Flow Rate	Maximum Pipe Diameter¹	Oil Storage Capacity	Typical Sediment Storage Capacity²	Minimum Distance from Outlet Invert to Top of Rim³	Chamber Depth
		NJDEP Certified						
	(ft / m)	(cfs / L/s)	(cfs / L/s)	(in / mm)	(gal / L)	(yd³ / m³)	(ft / m)	(ft / m)
FD-3HC	3 / 0.9	0.85 / 24.0	15 / 424	18 / 457	125 / 473	0.4 / 0.3	2.0 - 3.5 / 0.6 - 1.0	3.75 / 1.14
FD-4HC	4 / 1.2	1.50 / 42.4	18 / 510	24 / 600	191 / 723	0.7 / 0.5	2.3 - 3.9 / 0.7 - 1.2	5.00 / 1.52
FD-5HC	5 / 1.5	2.35 / 66.2	20 / 566	24 / 609	300 / 1135	1.1 / .84	2.5 - 4.5 / 0.7 - 1.3	5.25 / 1.60
FD-6HC	6 / 1.8	3.38 / 95.7	32 / 906	30 / 750	496 / 1878	1.6 / 1.2	3.0 - 5.1 / 0.9 - 1.6	6.25 / 1.90
FD-7HC	7 / 2.1	4.60 / 130.2	40 / 1133	42 / 1067	750 / 2839	2.1 / 1.9	3.0 - 5.5 / 0.9 - 1.7	7.25 / 2.20
FD-8HC	8 / 2.4	6.00 / 169.9	50 / 1,415	48 / 1219	1120 / 4239	2.8 / 2.1	3.0 - 6.0 / 0.9 -1.8	8.00 / 2.43

¹Contact Hydro International when larger pipe sizes are required.
²Contact Hydro International when custom sediment storage capacity is required.
³Minimum distance for models depends on pipe diameter.

III. Maintenance

Overview

The First Defense® protects the environment by removing a wide range of pollutants from stormwater runoff. Periodic removal of these captured pollutants is essential to the continuous, long-term functioning of the First Defense®. The First Defense® will capture and retain sediment and oil until the sediment and oil storage volumes are full to capacity. When sediment and oil storage capacities are reached, the First Defense® will no longer be able to store removed sediment and oil. Maximum pollutant storage capacities are provided in Table 1.

The First Defense® allows for easy and safe inspection, monitoring and clean-out procedures. A commercially or municipally owned sump-vac is used to remove captured sediment and floatables. Access ports are located in the top of the manhole.

Maintenance events may include Inspection, Oil & Floatables Removal, and Sediment Removal. Maintenance events do not require entry into the First Defense®, nor do they require the internal components of the First Defense® to be removed. In the case of inspection and floatables removal, a vactor truck is not required. However, a vactor truck is required if the maintenance event is to include oil removal and/or sediment removal.

Maintenance Equipment Considerations

The internal components of the First Defense®-HC have a centrally located circular shaft through which the sediment storage sump can be accessed with a sump vac hose. The open diameter of this access shaft is 15 inches in diameter (Fig.3). Therefore, the nozzle fitting of any vactor hose used for maintenance should be less than 15 inches in diameter.

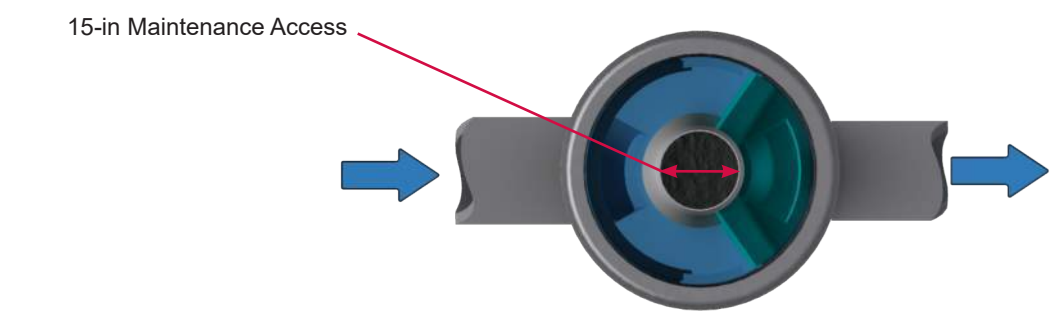


Fig.3 The central opening to the sump of the First Defense®-HC is 15 inches in diameter.

Determining Your Maintenance Schedule

The frequency of clean out is determined in the field after installation. During the first year of operation, the unit should be inspected every six months to determine the rate of sediment and floatables accumulation. A simple probe such as a Sludge-Judge® can be used to determine the level of accumulated solids stored in the sump. This information can be recorded in the maintenance log (see page 9) to establish a routine maintenance schedule.

The vactor procedure, including both sediment and oil / flotables removal, for a 6-ft First Defense® typically takes less than 30 minutes and removes a combined water/oil volume of about 765 gallons.

Inspection Procedures

1. Set up any necessary safety equipment around the access port or grate of the First Defense® as stipulated by local ordinances. Safety equipment should notify passing pedestrian and road traffic that work is being done.
2. Remove the grate or lid to the manhole.
3. Without entering the vessel, look down into the chamber to inspect the inside. Make note of any irregularities. Fig.4 shows the standing water level that should be observed.
4. Without entering the vessel, use the pole with the skimmer net to remove floatables and loose debris from the components and water surface.
5. Using a sediment probe such as a Sludge Judge®, measure the depth of sediment that has collected in the sump of the vessel.
6. On the Maintenance Log (see page 9), record the date, unit location, estimated volume of floatables and gross debris removed, and the depth of sediment measured. Also note any apparent irregularities such as damaged components or blockages.
7. Securely replace the grate or lid.
8. Take down safety equipment.
9. Notify Hydro International of any irregularities noted during inspection.

Floatables and Sediment Clean Out

Floatables clean out is typically done in conjunction with sediment removal. A commercially or municipally owned sump-vac is used to remove captured sediment and floatables (Fig.5).

Floatables and loose debris can also be netted with a skimmer and pole. The access port located at the top of the manhole provides unobstructed access for a vactor hose and skimmer pole to be lowered to the base of the sump.

Scheduling

- Floatables and sump clean out are typically conducted once a year during any season.
- Floatables and sump clean out should occur as soon as possible following a spill in the contributing drainage area.



Fig.4 Floatables are removed with a vactor hose (First Defense model FD-4, shown).

Recommended Equipment

- Safety Equipment (traffic cones, etc)
- Crow bar or other tool to remove grate or lid
- Pole with skimmer or net (if only floatables are being removed)
- Sediment probe (such as a Sludge Judge®)
- Vactor truck (flexible hose recommended)
- First Defense® Maintenance Log

Floatables and sediment Clean Out Procedures

1. Set up any necessary safety equipment around the access port or grate of the First Defense® as stipulated by local ordinances. Safety equipment should notify passing pedestrian and road traffic that work is being done.
2. Remove the grate or lid to the manhole.
3. Without entering the vessel, look down into the chamber to inspect the inside. Make note of any irregularities.
4. Remove oil and floatables stored on the surface of the water with the vactor hose (Fig.5) or with the skimmer or net (not pictured).
5. Using a sediment probe such as a Sludge Judge®, measure the depth of sediment that has collected in the sump of the vessel and record it in the Maintenance Log (page 9).
6. Once all floatables have been removed, drop the vactor hose to the base of the sump. Vactor out the sediment and gross debris off the sump floor (Fig.5).
7. Retract the vactor hose from the vessel.
8. On the Maintenance Log provided by Hydro International, record the date, unit location, estimated volume of floatables and gross debris removed, and the depth of sediment measured. Also note any apparent irregularities such as damaged components, blockages, or irregularly high or low water levels.
9. Securely replace the grate or lid.

Maintenance at a Glance

Inspection	- Regularly during first year of installation - Every 6 months after the first year of installation
Oil and Floatables Removal	- Once per year, with sediment removal - Following a spill in the drainage area
Sediment Removal	- Once per year or as needed - Following a spill in the drainage area
NOTE: For most clean outs the entire volume of liquid does not need to be removed from the manhole. Only remove the first few inches of oils and floatables from the water surface to reduce the total volume of liquid removed during a clean out.	



Fig.5 Sediment is removed with a vactor hose (First Defense model FD-4, shown).



First Defense® Installation Log

HYDRO INTERNATIONAL REFERENCE NUMBER:	
SITE NAME:	
SITE LOCATION:	
OWNER:	CONTRACTOR:
CONTACT NAME:	CONTACT NAME:
COMPANY NAME:	COMPANY NAME:
ADDRESS:	ADDRESS:
TELEPHONE:	TELEPHONE:
FAX:	FAX:

INSTALLATION DATE: / /

MODEL SIZE (CIRCLE ONE): FD-3HC FD-4 FD-4HC FD-5HC FD-6 FD-6HC

FD-7HC FD-8HC

INLET (CIRCLE ALL THAT APPLY): GRATED INLET (CATCH BASIN) INLET PIPE (FLOW THROUGH)



First Defense® Inspection and Maintenance Log

Date	Initials	Depth of Floatables and Oils	Sediment Depth Measured	Volume of Sediment Removed	Site Activity and Comments

Appendix J: VortClarex Oil/Water Separator Maintenance Guidelines

Oil Water Separators

VortClarex®

Design and Operation

Basic Operation

Conventional oil/water separators operate on the principal of gravity separation, using baffles or T-pipe sections to retain free-floating oils. With their limited treatment capacities, they are only effective on oil droplets greater than 150 microns. The VortClarex® system builds on this conventional oil/water separator design by incorporating an innovative media designed to maximize the surface area available for the coalescing of oil droplets. A typically sized VortClarex is capable of removing oil droplets down to 60 microns.

The coalescing media or corrugated plates provide a surface onto which oil droplets coalesce. The calcium filled polypropylene media attracts oily substances because of its affinity for hydrocarbons (oleophilic). Oil droplets are then able to combine, forming larger droplets that rise to the surface more quickly - increasing the separation rate and reducing hydrocarbon levels in the effluent. When properly sized the VortClarex system will provide an effluent quality of 10 ppm (parts per million) or less for most stormwater applications.

Flow enters the VortClarex system via a non-clog diffuser that distributes it across the chamber width. The influent passes over a solids baffle wall where settleable solids drop out, reducing the amount of solids in the flow as it enters the coalescing media. As the flow passes through the media, oil droplets accumulate on the surface and come into contact with others to form larger, more buoyant droplets. These larger droplets rise upward through the media and are released near the water surface. The oil is trapped behind the outlet T-pipe, and treated water exits the system.

Maintenance

Inspection

The VortClarex system should be checked periodically to determine if excessive amounts of solids and/or oils have accumulated. Solids accumulation in the lower sections of the VortClarex coalescing media will reduce oil removal efficiencies. Regular inspection and maintenance will eliminate any compromise in performance due to solids build-up.

After the first six (6) months of operation, the inlet area should be inspected and cleaned as follows:

1. Remove separator cover.
2. Dispose of separated oil per regulatory procedures.
3. Remove water from separator.
4. Clean the vault by flushing with a hose and examine the plates for blockage.
5. Remove accumulated sediment with a vacuum truck or positive displacement pump such as an air operated diaphragm pump. The sediment will contain hydrocarbons so proper disposal is required.

Note: Measure and record the depth of the solids in the inlet chamber. If sediment level is 6 inches or more, the cleaning interval should be shortened. If the sediment is less than 6 inches deep, the interval can be increased.

Cleaning

The VortClarex coalescing media can be cleaned either while in the system or after removal from the system.

Cleaning in place

1. Using a water hose, direct spray (10-15 psi) into plate spacing on top of the plate packs.
2. Using a vacuum suction hose, remove any sediment or oily contaminants that are flushed out of the coalescing media.

Cleaning after removal

1. Pump all water and oily contaminants from the VortClarex system.
2. Remove coalescing media.
3. Place media on an impervious surface lined with 6 mil plastic sheeting surrounded by a berm to prevent discharge of contaminated water into surface or groundwater.
4. Flush media with water hose (10-15 psi) to remove heavy oil coating or sludge from between the corrugated plates.
5. Examine tank interior for damage and repair any damage to internal coating.
6. Re-Install plate packs one at a time, one row in length and one row in width, being sure the outer packs are adequately sealed against the vault wall in the same manner as before they were removed.
7. After all packs are installed, check to ensure that the packs are even and touching, forming one (or two if provided) rows of packs across the channel and that they are securely butted against the backing angle at the bottom of the separator. Install the upper channel to ensure the plates are secured in place.
8. Secure hold down channel ensuring it is snugly in place.
9. Check to see that there is no possibility of fluid bypassing around the plates and the side wall of the vault, as well as between plate pack assemblies, since this could adversely affect the efficiency of the separator.

Appendix K: Commercial/Private Facility Inspection Procedure

Appendix K

Commercial/Private Facility Inspection Procedure

Work Flow Tracking (Setting up Inboxes)

Cityworks has been formatted to track the Commercial Inspection process. The Commercial Inspection Program Manager will need to follow these instructions to manage work flow.

The work flow tracking relies on Inboxes using the **Work Order** panel's **Cur Insp Status** drop down box and the **Actual Start** date, and the **Projected Finish** date. ***These must be kept current to track the work flow.*** Correspondence to the landowners will be generated as Reports, also based on the Current Inspection Status, Actual Start date, and Projected Finish date.

When initially creating inboxes from Saved Work Order Searches, they will have these Search parameters in common:

1. **Entity Group** = Surface Water
2. **Entity Type** = Stormwater Facility
3. **Description** = Commercial Inspection
4. **Projected Start** = Projected Start date for that year
5. **Closed** = N

Each Inbox should have these Fields Visible in Search Results:

1. Description
2. Location
3. Address
4. Projected Start Date
5. Actual Start Date
6. Resolution
7. Status

The following Inboxes are required to track work status, and create correspondence:

1. To Be Inspected
 - a. Send Initial Inspection Notice: Based on the generic search parameters above, and Resolution = 00 – Send Initial Notice of Inspection
 - b. Ready for Initial Inspection: Based on the generic search parameters above, and Resolution = 01 - Initial Notice of Inspection Sent
 - c. Reinspection Required: Based on the generic search parameters above, and Resolution = 07 - Rec'd DIY-2nd Inspection

2. Not Met Standards (NMS) Facilities

- a. Fail First Inspection: Based on the generic search parameters above, and Resolution = 03 - Fail Initial Inspection
- b. Fail Second (or more) Inspection: Based on the generic search parameters above, and Resolution = 09 - Fail 2nd Inspection

3. NMS Notices

- a. Send 1st Failure Notice: Based on the generic search parameters above, and Resolution = 04 - Send Initial Notice of Failure
- b. 1st Failure Notice Sent: Based on the generic search parameters above, and Resolution = 05 - 1st Notice of Failure Sent
- c. Send Final Failure Notice-Reinspection, based on the generic search parameters above, and Resolution = 10 - Send Certified Final Notice of Failure-Reinspect
- d. Send Final Failure Notice, based on the generic search parameters above, and Resolution = 11 - Send Certified Final Notice of Failure
- e. Final Failure Notice Sent, based on the generic search parameters above, and Resolution = 12 - Certified Final Notice of Failure Sent
- f. Final Failure: Based on the generic search parameters above, and Resolution = 16 - Does Not Meet Standards for the Year

4. Met Standards (MS) Facilities

- a. Pass Initial Inspection: Based on the generic search parameters above, and Resolution = 02 - Pass Initial Inspection
- b. Professional Corrective Action Received: Based on the generic search parameters above, and Resolution = 06 - Received C.A. Notice and Receipt
- c. Pass Upon Correction: Based on the generic search parameters above, and Resolution = 08 - Pass Upon Correction

5. MS Notices

- a. Send Notice of Pass Initial Inspection: Based on the generic search parameters above, and Resolution = 13 - Send Notice of Pass-Initial
- b. Send Notice of Pass Reinspection: Based on the generic search parameters above, and Resolution = 14 - Send Notice of Pass-Reinspect
- c. Notice of Pass Sent: Based on the generic search parameters above, and Resolution = 15 - Notice of Pass Sent

Id	Proj Start Date	Proj Finish Date	Actual Start	Location	Resolution
2032	5/5/2014 1:28 PM	7/17/2014 10:12 AM		12003	03 - FAIL INITIAL INSPEC
2042	5/5/2014 1:25 PM	03120			09 - FAIL 2ND INSPECTION

(Sample of select Inboxes in the Commercial Inspection process)

Initial Inspection Set-up – Create a Saved Search

1. Create an **Asset Search** based on the facility inspection cycles. The inspection cycles are:
 - Annually
 - Even Year
 - Odd Year
- a. In the **Entity Group** drop down box, select **Surface Water**.
- b. In the **Entity** drop down box, select **Stormwater Facility**.
- c. In the **Inspect_Cycle** drop down box, select the inspection cycle appropriate for that year. For example, in 2016, the City will inspect all facilities on an Annual cycle and on the Even Year cycle, so use the 'Ctrl' button to select both inspection cycles.
- d. In the **OperatedBy** drop down box, select **City-Commercial**.
- e. Click **Save As...**

- f. Name the Asset Search “Even/Odd Year Commercial Inspections”, as appropriate.

The screenshot displays the Cityworks GIS Search interface. The top navigation bar includes 'Cityworks', 'Inbox', 'Work Order', 'Request', 'Inspection', 'Asset Search', and 'Managers'. Below this is a search bar with 'Search', 'Clear', 'Open', and 'Save As...' buttons.

The main search panel is titled 'GIS Search' and contains several sections:

- Feature/Entity Selection:** 'Feature' is set to 'Surface Water' (highlighted with a red box) and 'Entity' is set to 'STORMWATER FACILITY'.
- Limit by extent:** A checkbox that is currently unchecked.
- Attached to WO:** Fields for 'WO Templates' and 'WO Status'.
- Attached to Insp:** Fields for 'Insp Templates' and 'Insp Status'.
- Attached to Case:** Fields for 'Case Type' and 'Case Status'.
- Search GIS data by entering / selecting values for the following attributes:**
 - OBJECTID:** A text input field.
 - NAME:** A text input field.
 - INSPECT_CYCLE:** A dropdown menu set to 'Annually, Even Year' (highlighted with a red box).
 - INSPECT_NOTES:** A text input field.
 - MERGED_FROM:** A text input field.
 - LegacyID:** A text input field.
 - EstimatedEffectiveLife:** A text input field.
 - Condition:** A dropdown menu.
 - created_user:** A text input field.
 - last_edited_user:** A text input field.
 - LifeCycle:** A dropdown menu.
 - DIGITIZE_SOURCE:** A text input field.
 - OperatedBy:** A dropdown menu set to 'City-Commercial' (highlighted with a red box).
 - SHAPE.STArea():** A text input field.
 - MAINT_ZONE:** A dropdown menu.
 - BMP:** A dropdown menu.
 - Location:** A text input field.
 - INFILTRATION:** A dropdown menu.
 - AssetID:** A text input field.
 - WarrantyDate:** A date picker.
 - InstallYear:** A text input field.
 - GlobalID:** A text input field.
 - created_date:** A date picker.
 - last_edited_date:** A date picker.
 - OwnedBy:** A dropdown menu.
 - DIGITIZE_METHOD:** A dropdown menu.
 - FacilityID:** A text input field.
 - SHAPE.STLength():** A text input field.
 - Basin:** A dropdown menu.

On the right side, the 'Search Query' panel shows the current query: 'INSPECT_CYCLE (String): Annually, Even Year. OperatedBy (String): City-Commercial.' Below this is a 'Visible Fields in Search Results' section with a 'Sort' button and a list of fields: OBJECTID, Location, NAME, INSPECT_CYCLE, INSPECT_NOTES, INFILTRATION, MERGED_FROM, AssetID, LegacyID, WarrantyDate, EstimatedEffectiveLife, InstallYear, Condition, GlobalID, created_user, created_date, last_edited_user, last_edited_date, LifeCycle, OwnedBy, DIGITIZE_SOURCE, DIGITIZE_METHOD, OperatedBy, FacilityID, SHAPE.STArea(), SHAPE.STLength(), MAINT_ZONE. At the bottom, the 'Sort Results by Field' section shows 'OBJECTID' selected and 'Descending' checked.

2. Open the Saved Asset Search, created in Step 1 above.
3. Create a Commercial Inspection Work Order for **each** Facility.
 - a. From the Asset Search, select the facilities.
 - b. From the **Data tab**, select **Create WO**.
 - c. A new **Select Template** Work Order panel will open.
 - d. From the **Entity Group** drop down, choose Surface Water. In the selection boxes, choose **Stormwater Facility** and **Commercial Inspection**.



Cityworks

Inbox

Work Order

Request

Inspection

Asset Search

Managers

GIS Search Criteria

Data

Create WO

Search WO

Create Insp

Search Insp

Create Permit

Search Permit

Relationships

Change Out

Export

Drag a column header and

OBJECTID

Location

	NAME	INSPECT_CYCLE	INSPECT_NOTES
3	Newcastle Apartments	Even Year	None
4	Forest Creek Apts	Annually	None
6	McDonald's - Bothell Way NE	Annually	None
11	US Bank	Even Year	None
18	Fircrest Residential Habilitation Center	Annually	Contact prior to inspection - Byron Heichel - 206-361-2990. Sign in at Bldg. 35.
21	Aurora Square	Annually	None
26	Park Richmond Condominiums	Even Year	Contact manager for gate access prior to inspection
43	Compton West Condominium	Even Year	None
108	Bonnie Marie Triplex	Even Year	None
111	Four-Plex Apts	Even Year	None
112	Aegis of Shoreline/Callahan House	Annually	None
113	Shoreline Christian School	Even Year	None
114	Northgate Townhouses	Even Year	None
129	Animal Surgical Clinic of Seattle	Annually	None
130	19940 Building	Annually	None
131	Maaco Auto Painting & Bodywork	Even Year	Sump Pump in CB3/34569
132	Fifteen O Fifteen Apartments	Even Year	None
134	Aurora Center	Even Year	None
136	Center for Human Services	Annually	None
139	Richmond Firs Condominiums	Even Year	Small detention pond/area present
141	4-Plex	Even Year	None
143	Brinton Apartments	Even Year	None
144	Alston Apartments	Annually	None
145	Lake Forest Park Condos	Even Year	None
146	Canterbury Court Apts	Even Year	None
147	LFP Properties	Even Year	None
148	Kuleana Forest Hills Condominiums	Even Year	None
149	North Forest Apts	Annually	None
150	Safeway Store # 0497	Annually	None
151	North City Place Apartments (formerly The Firs Apts)	Annually	None

- e. In the **General** panel, set these parameters:
 - i. Status = **Initiated**
 - ii. Requested by = **Your Name**
 - iii. Submit to = **Default**
 - iv. Projected Start = **Date projected to start, usually May**
 - v. Expense Type = **Maintenance**
- f. Go to the Selected Assets panel. In the Create a work order for drop down box, select EACH selected entity.

The screenshot displays the 'Create New Work Order' form in the Cityworks application. The interface is divided into three main panels:

- Select Template:** A sidebar on the left with a search bar and a list of templates. 'Surface Water' is selected under the 'Entity Group'.
- General:** A central panel with various fields. Red boxes highlight the 'Status' (INITIATED), 'Requested By' (NANCEVICH, MELISSA), 'Submit To' (NANCEVICH, MELISSA), 'Stage' (Actual), 'Shop' (SURFACE WATER), 'Priority' (Medium), 'Projected Start' (05/1/2017 12:00 PM), and 'Expense Type' (Maintenance) fields.
- Selected Assets:** A panel on the right showing a table of facilities. A red box highlights the 'Create a work order for' dropdown, which is set to 'EACH selected entity'. Below the table, there is a section for 'Open Work Activities'.

- g. Select **Create**. Separate Commercial Inspection Work Orders will be created for each facility.
- h. Select the **Apply to All** check box.
- i. In the **Work Order** panel, find the **Cur Insp Status** drop down box. Select **00 – Send Initial Notice of Inspection**.

The screenshot shows the Cityworks Work Order form. The 'Cur Insp Status' dropdown is highlighted with a red box, showing a list of inspection status options. The 'Apply To All' checkbox is also highlighted with a red box.

Cityworks | **Inbox** | **Work Order** | **Request** | **Inspection** | **Asset**

Work Order | **Email** | **Print** | **Save** | **Close** | **Delete**

Work Order

Description: [Dropdown]
 Number: 13526 (186 Records) | **Apply To All:** ☒
 Entity Type: [Dropdown] | **Change**

Category: [Dropdown]

Initiated By: [Dropdown] | Date: [Calendar]
 Status: [Dropdown] | Priority: [Dropdown]
 Requested By: [Dropdown] | Supervisor: [Dropdown]
 Submit To: [Dropdown] | Date: [Calendar]
 Projected Start: [Calendar] | Projected Finish: [Calendar]
 Opened By: [Dropdown] | Date: [Calendar]
 Completed By: [Dropdown] | **GIS Update?** [Dropdown]
 Closed By: [Dropdown] | Date: [Calendar]
 Actual Start: [Calendar] | **Actual Finish:** [Calendar]
 Stage: [Dropdown] | Expense Type: [Dropdown]

Cur Insp Status: **00 - SEND INITIAL NOT** | **00 - SEND INITIAL NOTICE OF INSPECTION**

Add Comments: 01 - INITIAL NOTICE OF INSPECTION SENT
 02 - PASS INITIAL INSPECTION
 03 - FAIL INITIAL INSPECTION
 04 - SEND 1ST NOTICE OF FAILURE
 05 - 1ST NOTICE OF FAILURE SENT
 06 - RECD C.A. NOTICE AND RECEIPT
 07 - RECD DIY-2ND INSPECTION
 08 - PASS UPON CORRECTION
 09 - FAIL 2ND INSPECTION
 10 - SEND CERTIFIED FINAL NOTICE OF FAILURE-REINSPECT
 11 - SEND CERTIFIED FINAL NOTICE OF FAILURE
 12 - CERTIFIED FINAL NOTICE OF FAILURE SENT
 13 - SEND NOTICE OF PASS-INITIAL
 14 - SEND NOTICE OF PASS-REINSPECT
 15 - NOTICE OF PASS SENT
 16 - DOES NOT MEET STANDARDS FOR THE YEAR

Existing Comments:

Instructions:

Reactive? ☐

Details

Project: [Dropdown] | Account: [Dropdown]
Project Tree
 Contract: [Dropdown] | Contractor: [Dropdown]

- j. Save the Work Orders.
4. Create a **Work Order** search for the Work Orders created in the step above.
 - a. In the **Entity Group** drop down box, select **Surface Water**.
 - b. In the **Entity** drop down box, select **Stormwater Facility**.
 - c. In the **Descriptions** drop down box, select **Commercial Inspection**.
 - d. In the **Work Order** panel, find the **Cur Insp Status** drop down box. Select **00 – Send Initial Notice of Inspection**.
 - e. Click **Save As...**
 - f. Name the Work Order search “Commercial Inspections - Send Initial Inspection Notice”.

Cityworks | Inbex | Work Order | Request | Inspection | Asset Search | Managers

Search | Clear | Open | Save As...

General | Details | Tasks | Custom Fields | Labor Fields | GIS | UCF

General

WO ID(s): | Domain: |

Entity Group: Surface Water | **Entity Type:** STORMWATER FACILITY |

Category: | **Descriptions:** COMMERCIAL INSPECTION |

Status: | **Priority:** |

Requested By: | **Initiated By:** |

Submit To: | **Supervisor:** |

Projected Start: | **Projected Finish:** |

Opened By: | **Closed By:** |

Completed By: | **Cur Insp Status:** 00 - SEND INITIAL NOTICE OF INSPECTION |

Actual Start: | **Actual Finish:** |

Unattached? | **Past Due:** |

Stage: | **Expense Type:** |

Has Request: | **Has Inspection:** |

GIS Update? | **Has Attachment:** |

Has PII Case: | **Cancelled?** |

Reactive? | **Init App** |

Request ID(s) |

Entity and Feature Info

Entity Group: | **Entity Types:** |

Feature Group: | **Feature Types:** |

Search Query

Entity Group: Surface Water.
Apply to Entity: STORMWATER FACILITY.
Description: COMMERCIAL INSPECTION.
Cur Insp Status: 00 - SEND INITIAL NOTICE OF INSPECTION.

Fields Visible in Search Results

Sort

Entity Type

Description
Priority
Status
Submit To
Proj Start Date
Proj Finish Date
Actual Start
Actual Finish
Shop
Maint Zone
Basin
Address
Location
Entity Group
Category
Initiated By
Date Initiated
Date Submit To
Completed By
Supervisor
Update Map
Legal Billable
Contractor Billable
Project
Account
Expense Type

Task Fields Visible in Search Results

Task Id
Task Name
Task Description
Task Assigned To
Task Shop
Task Code
Task Prj Start Date
Task Prj Finish Date
Task Act Start Date
Task Act Finish Date
Task Status
Task Entity

Initial Inspection Set-up - Create the Initial Notice of Inspection Report

1. Open **Managers** → **SSRS Reports**
2. Open the **PWORKS Folder**



3. Select "SW_Letter_Pre_Inspection_Notice"
4. Export the letters to PDF.

5. Print Letters.

- a. Envelopes need to be generated from this table:
J:\GIS\UTIL\Cityworks\StormwaterFacilityContacts_Open.xlsx
 - b. Select “Enable Content”, then “No” in the popup window for ‘Do you want to make this file a Trusted Document’. Go to the **Data** tab and select “Refresh All.”
 - c. Filter the resolution status for “00 – Send Initial Notice of Inspection”.
 - d. Save spreadsheet in the current year folder at:
G:\PWORKS\OPERATIONS\SWM\Commercial Facilities\2_Annual_Inspections
 - e. Open the Envelopes template, located here: G:\PWORKS\OPERATIONS\SWM\Commercial Facilities\3_Letter Templates\1_Current Letter Templates\Envelopes Template.docx
 - f. Select “Yes” to open the document.
 - g. Go to the **Mailings** tab and Select “**Use an Existing List**” from the “**Select Recipients**” dropdown within **Start Mail Merge**.
 - i. Navigate to the spreadsheet you saved in step d.
 - ii. Select “OK”.
 - h. Select “**Edit Individual Documents**” from the “Finish & Merge” dropdown.
 - i. Select “OK”. A new Word document will open.
 - i. Save the document in the current year folder at:
G:\PWORKS\OPERATIONS\SWM\Commercial Facilities\2_Annual_Inspections
 - j. Print Envelopes.
6. Once the letters have been mailed, open the **Send Initial Inspection Notice** Inbox tab.
 7. Select all Work Orders in the **Send Initial Inspection Notice** Inbox.
 8. Add the labor associated with the creation and mailing of the Initial Notice of Inspection.
 - a. Select **Open in ELM** in the Open dropdown. A new tab titled **ELM** will open.

Send Initial Inspection Notice									
Open	Print	Expand	Configure	Map	Search...				
Open in ELM					Priority	Status	Submit To	Proj Start Date	Proj Finish Date
<input checked="" type="checkbox"/>	13147	COMMERCIAL INSPECTION	3	INITIATED	IVANCEVICH, MELISSA	2017-05-01 12:00:00 PM	2017-09-30 12:00:00 PM		
<input checked="" type="checkbox"/>	13148	COMMERCIAL INSPECTION	3	INITIATED	IVANCEVICH, MELISSA	2017-05-01 12:00:00 PM	2017-09-30 12:00:00 PM		
<input checked="" type="checkbox"/>	13149	COMMERCIAL INSPECTION	3	INITIATED	IVANCEVICH, MELISSA	2017-05-01 12:00:00 PM	2017-09-30 12:00:00 PM		
<input checked="" type="checkbox"/>	13150	COMMERCIAL INSPECTION	3	INITIATED	IVANCEVICH, MELISSA	2017-05-01 12:00:00 PM	2017-09-30 12:00:00 PM		
<input checked="" type="checkbox"/>	13151	COMMERCIAL INSPECTION	3	INITIATED	IVANCEVICH, MELISSA	2017-05-01 12:00:00 PM	2017-09-30 12:00:00 PM		
<input checked="" type="checkbox"/>	13152	COMMERCIAL INSPECTION	3	INITIATED	IVANCEVICH, MELISSA	2017-05-01 12:00:00 PM	2017-09-30 12:00:00 PM		
<input checked="" type="checkbox"/>	13153	COMMERCIAL INSPECTION	3	INITIATED	IVANCEVICH, MELISSA	2017-05-01 12:00:00 PM	2017-09-30 12:00:00 PM		

Rows 200 1 – 190 of 190

- b. In the **Apply To** tab, select all Work Orders.

All Work Orders selected

The screenshot shows the 'Apply To' tab in the Cityworks interface. The 'Work Orders' table is displayed with columns 'Id', 'Description', and 'X'. All rows are selected, indicated by checkmarks in the 'Id' column. The 'Tasks' and 'Assets' sections are also visible on the right.

Id	Description	X
13157	COMMERCIAL INSPECTION	X
13158	COMMERCIAL INSPECTION	X
13159	COMMERCIAL INSPECTION	X
13160	COMMERCIAL INSPECTION	X
13161	COMMERCIAL INSPECTION	X
13162	COMMERCIAL INSPECTION	X
13163	COMMERCIAL INSPECTION	X
13164	COMMERCIAL INSPECTION	X
13165	COMMERCIAL INSPECTION	X
13166	COMMERCIAL INSPECTION	X

- c. Then select the **Add Costs** tab.
- d. Enter the **Date** at the top of the **Standard page**.
- e. In the **Labor** section, select the employee from the **Add Employee** dropdown.

The screenshot shows the 'Add Costs' tab in the Cityworks interface. The 'Date' field is highlighted with a red box. The 'Labor' section is expanded, and the 'Add Employee' dropdown is open, showing a list of employees with 'MANCEVICH, MELISSA' selected.

Add Costs

Date: 04/11/2017 8:10 AM

Account: select account

Standard Contractor

Crew: [dropdown]

Labor

Employee: [dropdown] hours

Add Employee

- HENRICH, LORI B
- HOLMQUIST, DONNA
- HORNBEAK, JAY
- HUIZAR, NANCY
- HUPPRICH, NOEL F
- MANCEVICH, MELISSA**
- JEHNNINGS, LORRIE
- JOHNSON, DAN

The employee will be added to the Labor section.

- f. Add the number of hours for the employee.
 - i. The hours will be divided amongst all of the Work Orders and will appear in the Existing Costs section at the bottom of the Add Costs tab once you select **Save**.
- g. Expand the **Advanced** section within the **Labor** section.
 - i. Enter "Mailing Preinspection Notice" in the **Description** section.
- h. Select **Save** on the right side of the screen.

- i. Close the ELM tab.
9. **Select and Open** all Work Orders in the **Send Initial Inspection Notice** Inbox again.
 10. In the **Custom Fields** panel, enter the date the letters were mailed in the **Inspection Notice** field. Save the Work Order and repeat for each Work Order until all are completed (Apply to All does not work for the Custom Fields).

11. **Select and Open** all Work Orders in the **Send Initial Inspection Notice** Inbox again.
12. Select **Apply to All** in the **Work Order** panel.

13. In the **Work Order** panel, find the **Cur Insp Status** drop down box. **Select 01 – Initial Notice of Inspection Sent.**

14. Save the **Work Orders** (These should now appear in your Inbox for “Ready for Initial Inspection”).

Initial Inspection Set-up – Updating Facility Information

1. Updating Facility Contact Information.
 - a. Open an Asset Search.
 - b. Select the radial button for Object.
 - c. In the Entity Group drop down box, select Surface Water.
 - d. In the Entity drop down box, select Facility Contact.
 - e. In the FacilityID field, enter the Facility Number. Search.

The screenshot shows the Cityworks GIS Search interface. The 'Object' radio button is selected. The 'Entity Group' is set to 'Surface Water' and the 'Entity' is set to 'FACILITY CONTACT'. The 'FacilityID' field is entered as '16005'.

- f. A new page will open with the contact(s) listed. Select the link in the **ObjectID** field for the contact that needs to be updated.

Cityworks GIS Search Criteria																
OBJECTID	PROPERTY_NAME	FacilityID	CONTACT_ID	CONTACT_TYPE	PROPERTY_ADDRESS	BUSINESS	NAME_1	NAME_2	ADDRESS_1	ADDRESS_2	CITY	STATE_ZIP	PHONE_1	PHONE_2	FAX	EMAIL
7174	Kellogg Middle School	16005	C16005a		16045 25th Ave NE	Shoreline School Dist. 412	Bruce Camp	Grounds Department	18560 1st Ave NE		Shoreline	WA 98155	206-393-4200			bruce.camp@shoreschools.org

- g. A new window titled **Asset Viewer** will open. Select **Edit** at the bottom of the Attributes tab.

Asset Viewer - FrontMotion Firefox

cityworks_test.shorelinewa.gov/cityworks_test/AssetView.aspx?EntityType=SWFACILITYCOMRESP&EntitySids=7174&EntityUi

Asset Viewer

Attributes Work History Relationships

PROPERTY_NAME	Kellogg Middle School
FacilityID	16005
CONTACT_ID	C16005a
CONTACT_TYPE	
PROPERTY_ADDRESS	16045 25th Ave NE
BUSINESS	Shoreline School Dist. 412
NAME_1	Bruce Camp
NAME_2	Grounds Department
ADDRESS_1	18560 1st Ave NE
ADDRESS_2	
CITY	Shoreline
STATE_ZIP	WA 98155
PHONE_1	206-393-4200
PHONE_2	
FAX	
EMAIL	bruce.camp@shorelineschools.org
CONTACT_NOTES	
ONSITE_NAME	
ONSITE_PHONE	
MULT_RESP	
created_user	RNOLET
created_date	04/12/2017
last_edited_user	Esri_Anonymous
last_edited_date	04/13/2017
Status	Active

Edit Flag Map

- h. Complete any edits, then Select **Save**.

Asset Viewer - FrontMotion Firefox

cityworks_test.shorelinewa.gov/cityworks_test/AssetView.aspx?EntityType=SWFACILITYCOMRESP&EntitySids=7174&EntityUi

Asset Viewer

Attributes Work History Relationships

PROPERTY_NAME	Kellogg Middle School
FacilityID	16005
CONTACT_ID	C16005a
CONTACT_TYPE	
PROPERTY_ADDRESS	16045 25th Ave NE
BUSINESS	Shoreline School Dist. 412
NAME_1	Bruce Camp
NAME_2	Grounds Department
ADDRESS_1	18560 1st Ave NE
ADDRESS_2	
CITY	Shoreline
STATE_ZIP	WA 98155
PHONE_1	206-393-4200
PHONE_2	
FAX	
EMAIL	bruce.camp@shorelineschools.org
CONTACT_NOTES	
ONSITE_NAME	
ONSITE_PHONE	
MULT_RESP	
created_user	RNOLET
created_date	04/12/2017
last_edited_user	Esri_Anonymous
last_edited_date	04/13/2017
Status	Active

Save Return Map

2. Updating Facility Name.

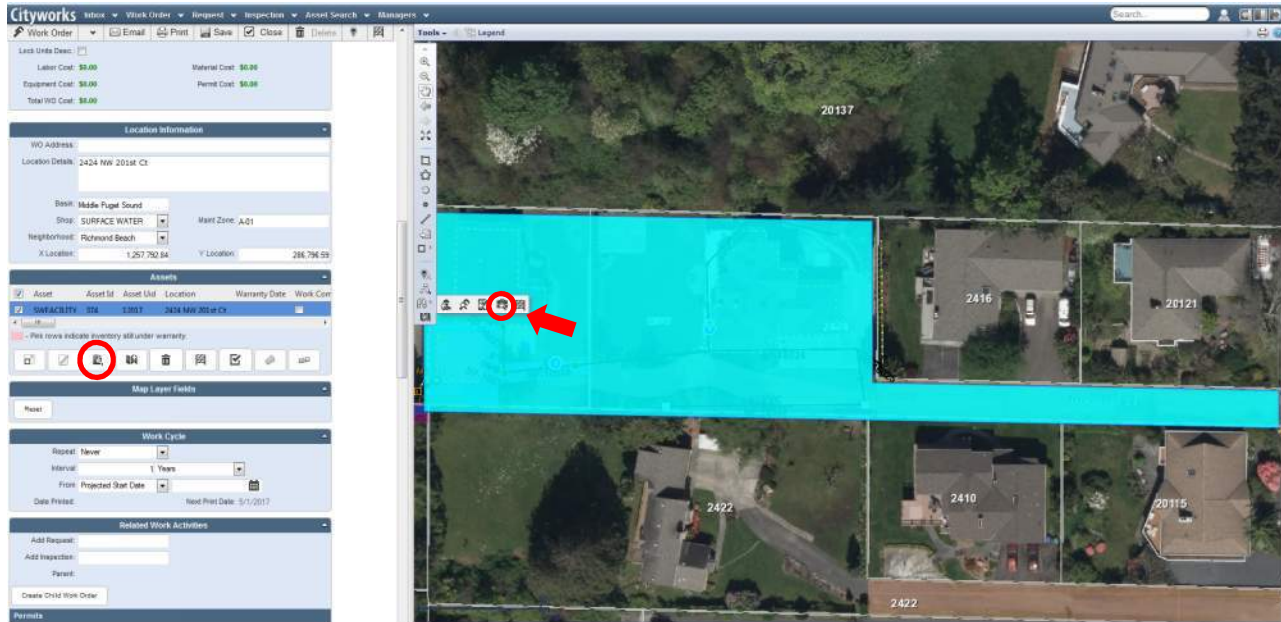
- If the name of the Facility/Property has changed, you will need to follow the steps above to update the name in the Facility Contact page in addition to the following steps: Open an **Asset Search**.
- The radial button for **Feature** should already be selected.
- In the **Entity Group** drop down box, select **Surface Water**.
- In the **Entity** drop down box, select **Stormwater Facility**.
- In the **AssetID** field, enter the **Facility Number**. Search.

The screenshot shows the Cityworks GIS Search interface. The top navigation bar includes 'Inbox', 'Work Order', 'Request', 'Inspection', 'Asset Search', and 'Map'. The 'Search' button is circled in red. Below the navigation bar is the 'GIS Search' window. The 'Feature' tab is selected and circled in red. The 'Entity Group' dropdown is set to 'Surface Water' and the 'Entity' dropdown is set to 'STORMWATER FACIL', both circled in red. The 'AssetID' field is set to '16001' and is also circled in red. The interface includes various filters for work orders, inspections, and cases, and a large grid of attribute fields for searching GIS data.

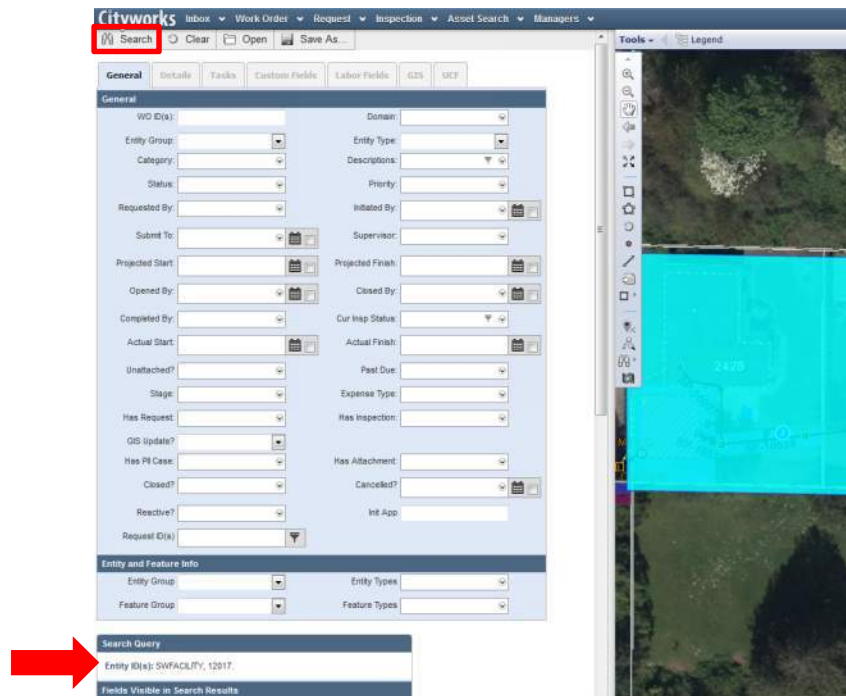
- A new page will open with the Facility listed. Select the link in the **ObjectID** field.
- A new window titled **Asset Viewer** will open. Select **Edit** at the bottom of the Attributes tab.
- Edit the **Name** and Save.

Initial Inspection Set-up – Add Assets to the WO

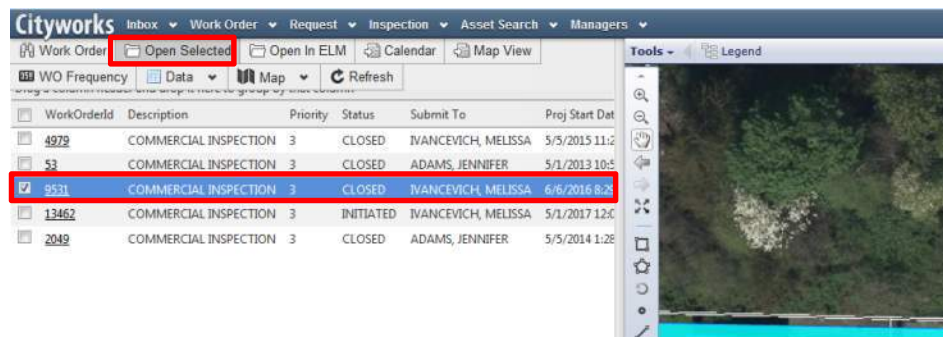
1. Open a WO.
2. In the **Assets** panel, select the SWFacility. Select the icon to “Highlight selected assets on the map”. This will show the facility on the map.
3. In the map view, select the binoculars icon to “Search work management...”
4. Select the wrench with the magnifying glass to “Search work orders.”



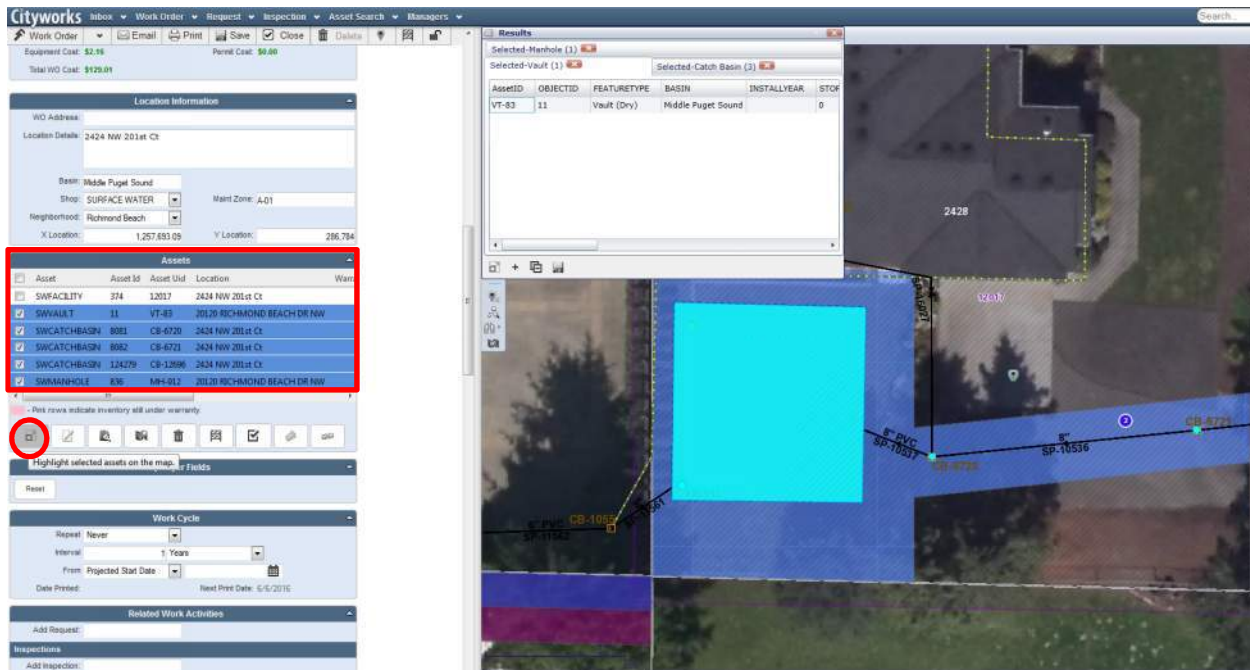
5. The WO Search tab will open with the facility selected in the Search Query Field. Select **Search** at the top of the page.
 - a. The WO search will show all related WO's for the selected facility.



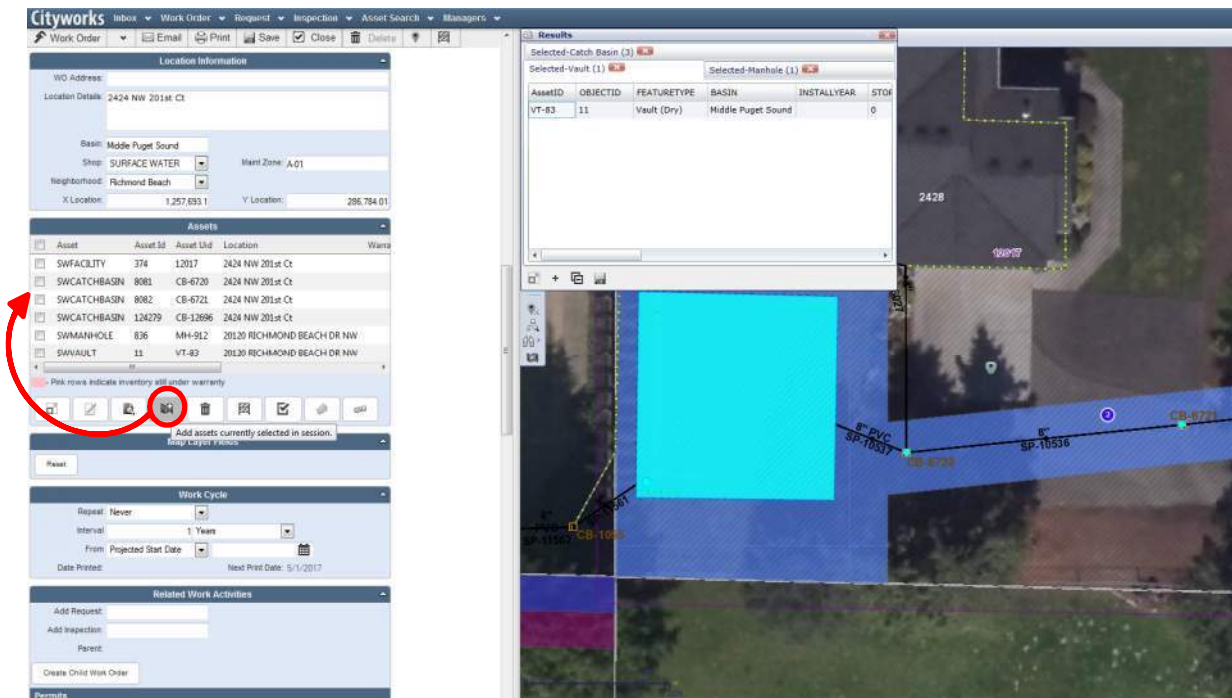
6. Select the most recent year's closed WO and **Open Selected**.



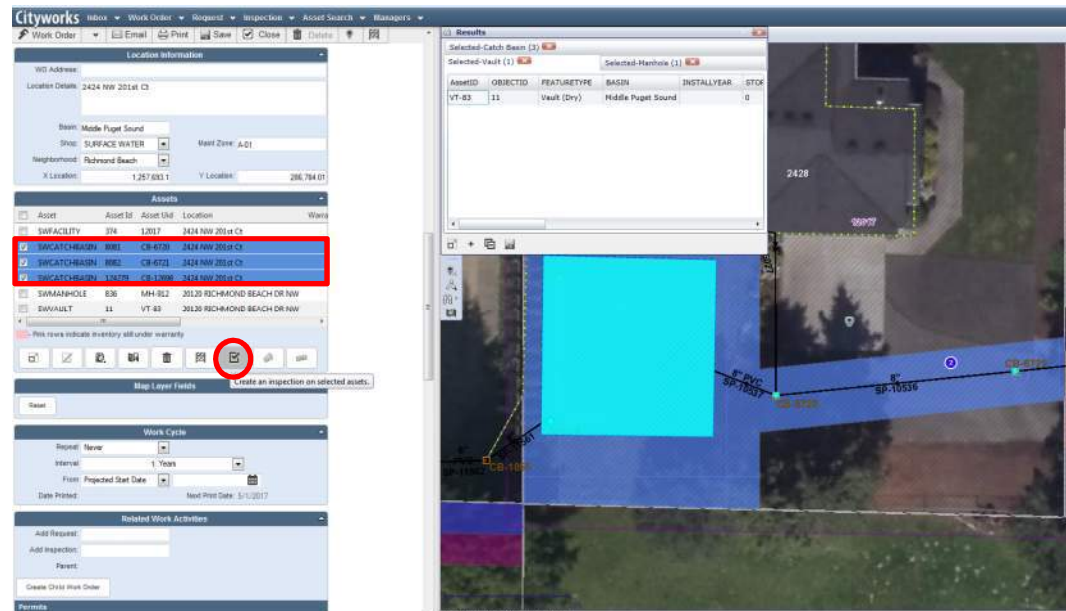
7. In the **Assets** panel, select all of the assets in the asset list, de-selecting SWFacility. Select the icon to "Highlight selected assets on the map". All of the assets associated with that facility will now be selected.



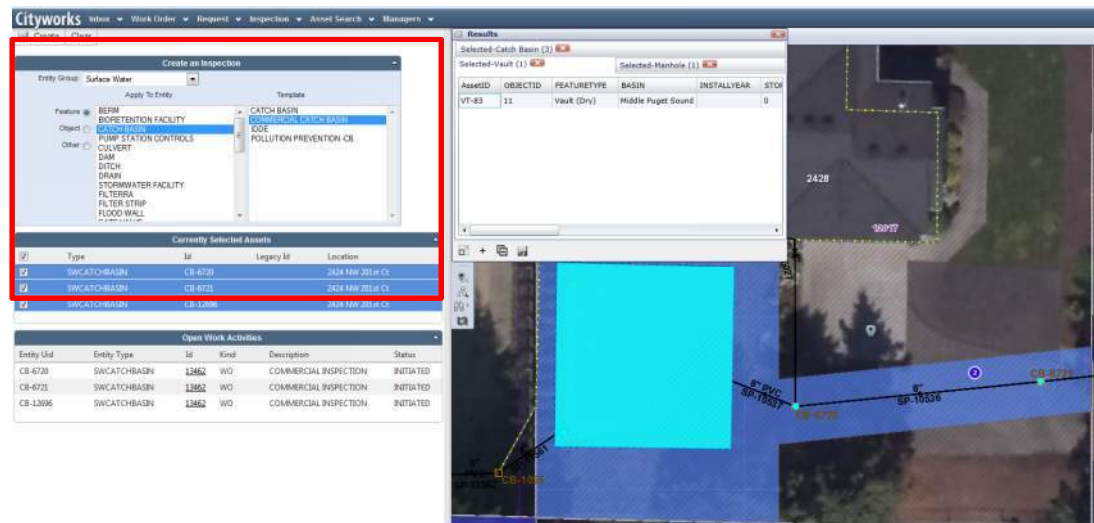
8. Hit the back button on the browser page to take you back to the WO's associated with the facility.
9. Select the current year's WO (the WO in the "Initiated" status) for the facility and select **Open Selected**.
10. In the **Assets** panel, select the icon to "Add assets currently selected in session." This will add all of the facility's assets to the current year's WO.



11. Create an inspection form for each asset, grouped by asset type (i.e. SWCatchBasin, SWManhole, SWVault, etc.).
 - a. In the **Assets** panel, select all assets within an asset group by checking the box next to the asset.
 - b. In the **Assets** panel, select the check mark for “Create an inspection on selected assets”. A new Inspection form will open.



- c. In the **Create an Inspection** panel, select the appropriate Feature for the **Entity**, and the appropriate **Commercial Template**. Create the Inspection.



- d. Repeat these steps for all WOs.

Field Inspections

Field inspections will require the use of a tablet to log observations. Every asset within the perimeter of the facility will be inspected and an inspection form completed for each asset.

1. Configure AMS layer to locate inspections, based on the same Saved Search used for “Ready for Initial Inspection”
2. Hover over the facility to be inspected. Ctrl+Click to open the associated Work Order.
3. In the **Assets** window, select the SWFacility. Select the icon to “Highlight selected asset on the map”. This will show the facility for inspection on the map.
4. Find the asset that connects to the City’s MS4 – start with that asset and work your way “upstream”.
5. Complete the Inspection form. In the **Observations** panel, only select categories where the asset Does NOT Meet Standards. All areas with no Observation will be assumed to Meet Standards.
6. If an asset meets standards, select “Inspection Complete” in the **Resolution** field on the **Inspection** tab, and complete the **Insp. Date** and **Inspection By** fields, then Save.

The screenshot shows the Cityworks software interface for an inspection. The top navigation bar includes 'Cityworks', 'Inbox', 'Work Order', 'Request', 'Inspection', and 'Asset Se'. Below this is a toolbar with 'Inspection', 'Save' (circled in red), 'Close', and other icons. The main form has tabs for 'Inspection' and 'Details'. The 'Inspection' tab is active, showing fields for 'ID' (37559), 'Location' (3434 NW 201st Dr), 'Status' (INITIATED), 'Resolution' (Inspection Complete), 'Insp. Date' (04/11/2017 3:15 PM), and 'Inspected By' (IVANCEVICH, MELISSA). Below these fields is the 'Observations' panel, which lists various categories with radio buttons for 'Does NOT Meet Standards' and 'Meets Standards'. The categories listed are: Sediment, Frame/Slab, Walls/Bottom, Ladder, Grate/Cover, Contamination, Vegetation, Inlet/Outlet, Trash and Debris, Catch Basin Inserts, and Cannot Locate.

7. Select the **Details** tab and complete the **Actual Finish** field, then **Close** the Inspection.

The screenshot shows the 'Cityworks' interface for an 'Inspection' record. The 'Details' tab is active. The 'Actual Finish' date is set to '04/11/2017 3:20 PM' and is highlighted with a red box. A red arrow points from a text box to the 'Open WO' button in the 'Related Work Activities' section.

Cityworks

Inspection

Details

Type: COMMERCIAL CATCH BASIN

Submit To: [Dropdown] Date: [Calendar]

Priority: [Dropdown]

Initiated By: INANCEVICH, MELISSA Initiated Date: 04/11/2017 2:36 PM

Projected Start: 04/11/2017 2:36 PM Projected Finish: [Calendar]

Actual Finish: 04/11/2017 3:20 PM [Calendar]

Cancel By: [Calendar] Date Closed: [Calendar]

Cancel Date: [Calendar]

Cancel WO?: ☐

Cancel Reason: [Text Area]

Cancelled By: [Text Area]

Location

Shop: [Dropdown] Basin: Middle Puget Sound

Maint Zone: A-01 Neighborhood: Richmond Beach

Map Layer Fields

Reset

Entity

Highlight Get from Map History Remove Asset Costs

Editable Fields: [Dropdown] All Fields: [Dropdown]

SWCATCHBASIN

Work Cycle

Repeat: Never

Interval: 0 Months

From: Actual Finish Date

Related Work Activities

Request: [Text Area]

Work Order: 13462 Open WO

Inspections:

Parent: [Text Area]

Create Child Inspection

Attachments

Takes you back to
the Parent WO

8. Return to the Parent Work Order.
9. If an asset within the Facility does **NOT** meet maintenance standards, select the radial button for **Does NOT Meet Standards** in the **Observations** section for each failure.
10. Once the inspection is complete for that asset, select "Corrective Work Required" in the **Resolution** field on the **Inspection** tab, and complete the **Insp. Date** and **Inspection By** fields, then Save.

Cityworks | **Inspection** | **Details**

Id: 37660 | Apply to All: ☐

Location: 2424 NW 201st Ct

Status: INITIATED | Resolution: Corrective Work Required

Insp. Date: 04/11/2017 3:37 PM | Inspected By: IVANCEVICH, MELISSA

Observations

Sediment

☒ Does NOT Meet Standards ☐ Meets Standards

Please clean sediments from the catch basin (disposal must be in accordance with Washington state law).

> 60% at lowest invert

Frame/Slab

☐ Does NOT Meet Standards ☐ Meets Standards

Walls/Bottom

☒ Does NOT Meet Standards ☐ Meets Standards

Please have the structure assessed for structural damage. Based on the report, have the structure repaired and/or replaced, as appropriate.

Judgment that structure is unsound or grout fillet crack > than 1/2 inch wide and >1foot long

Ladder

☐ Does NOT Meet Standards ☐ Meets Standards

Grate/Cover

☐ Does NOT Meet Standards ☐ Meets Standards

Contamination

☐ Does NOT Meet Standards ☐ Meets Standards

Vegetation

☐ Does NOT Meet Standards ☐ Meets Standards

Inlet/Outlet

11. For any observations that do not fit the generic categories, mark “Other” and record the findings in the **Observation** portion of the **Summary** section. **The Reports (below) to owners are triggered by a radio dial selection of Does Not Meet Standards. If you want to convey information to an owner, you must select this and record in observations.**
12. **Save** the Inspection – do not close an inspection for an asset that has not met standards.
13. Return to the Parent Work Order.
14. If all assets within the Facility **MEET** maintenance standards, complete the following fields in the Work Order:
 - a. Status: Work in Progress
 - b. Completed by: Your name
 - c. GIS Update? Y/N
 - d. Any Comments you may have about the Facility in general
 - e. Change **Cur Insp Status** to: **02 – Pass Initial Inspection**
 - f. Save Work Order

The screenshot shows the Cityworks Work Order form. The top navigation bar includes 'Inbox', 'Work Order', 'Request', 'Inspection', and 'Asset S'. Below this, there are icons for 'Work Order', 'Email', 'Print', 'Save', 'Close', and 'Delete'. The 'Close' button is highlighted with a red circle.

The main form area is titled 'Work Order' and contains the following fields:

- Description: COMMERCIAL INSPECTION
- Number: 13326
- Entity Type: SWFACILITY
- Category: PREVENTIVE
- Initiated By: IVANCEVICH, MELISSA
- Date: 04/11/2017 8:06 AM
- Status: WORK IN PROGRESS (highlighted with a red box)
- Priority: Medium
- Requested By: IVANCEVICH, MELISSA
- Supervisor: DELE, UKI
- Submit To: IVANCEVICH, MELISSA
- Date: 04/11/2017 8:06 AM
- Projected Start: 05/1/2017 12:00 PM
- Projected Finish: 05/1/2017 12:00 PM
- Opened By: IVANCEVICH, MELISSA
- Date: 4/13/2017 10:39:27 AM
- Completed By: IVANCEVICH, MELISSA (highlighted with a red box)
- GIS Update? NO (highlighted with a red box)
- Closed By:
- Date:
- Actual Start:
- Actual Finish:
- Stage: Actual
- Expense Type: Maintenance
- Cur Insp Status: 02 - PASS INITIAL INSPECTION (highlighted with a red box)
- Add Comments:
- Select
- Existing Comments:
- Instructions:
- Reactive? ☐

The bottom section of the form is titled 'Details' and contains the following fields:

- Project:
- Account:
- Project Tree
- Contract:
- Contractor:

15. If any asset within the Facility Does Not Meet Standards, then the Facility fails its initial inspection. Complete the following field in the Work Order:
 - a. Status: Work in Progress
 - b. Completed by: Your name
 - c. GIS Update? Y/N
 - d. Any Comments you may have about the Facility in general
 - e. Change **Cur Insp Status** to: **03 – Fail Initial Inspection**
 - f. Save Work Order

The screenshot shows the Cityworks Work Order form. The top navigation bar includes 'Cityworks', 'Inbox', 'Work Order', 'Request', 'Inspection', and 'Asset'. Below this, there are buttons for 'Work Order', 'Email', 'Print', 'Save', 'Close', and 'Delete'. The 'Save' button is highlighted with a red circle. The main form area is titled 'Work Order' and contains the following fields:

- Description: COMMERCIAL INSPECTION
- Number: 13320
- Entity Type: SWFACILITY
- Category: PREVENTIVE
- Initiated By: IVANCEVICH, MELISSA
- Date: 04/11/2017 8:06 AM
- Status: WORK IN PROGRESS (highlighted with a red box)
- Priority: Medium
- Requested By: IVANCEVICH, MELISSA
- Supervisor: DELE, UKI
- Submit To: IVANCEVICH, MELISSA
- Date: 04/11/2017 8:06 AM
- Projected Start: 05/1/2017 12:00 PM
- Projected Finish: 05/1/2017 12:00 PM
- Opened By: IVANCEVICH, MELISSA
- Date: 4/13/2017 11:31:14 AM
- Completed By: IVANCEVICH, MELISSA (highlighted with a red box)
- GIS Update?: YES (highlighted with a red box)
- Closed By:
- Date:
- Actual Start:
- Actual Finish:
- Stage: Actual
- Expense Type: Maintenance
- Cur Insp Status: 03 - FAIL INITIAL INSP (highlighted with a red box)
- Add Comments: CB-12345 is a downspout drain, not a type II CB.
- Existing Comments:
- Instructions:
- Reactive? ☐

At the bottom, there is a 'Details' section with fields for Project, Account, Project Tree, Contract, and Contractor.

1. Some Facilities will require a re-inspection.
 - a. Create another Inspection record for any of the assets that did not meet standards during the initial inspection. Close the Inspection record from the initial inspection.
 - b. Follow steps 5-13 above for completing the inspection.
 - c. If all re-inspected assets Meet Standards, simply change the **Cur Insp Status** in the Work Order panel to **08 – Pass Upon Correction**.
 - d. If an asset Does NOT Meet Standards upon re-inspection, return to the Parent Work Order after recording the failed re-inspection Observations. Update the **Cur Insp Status** to: **09 – Fail 2nd Inspection**.
2. Record the labor and equipment after each inspection.
 - b. Before exiting the Facility Work Order, select **ELM** in the dropdown next to Work Order. A new tab titled **ELM** will open.
 - c. Select the **Add Costs** tab.
 - d. Enter the **Date** at the top of the **Standard** page.

- e. In the **Labor** section, select the employee from the **Add Employee** dropdown.
 - f. Select all employees conducting the inspection – the employees will be added to the Labor section.
 - g. Add the number of hours for each employee.
 - h. Expand the **Advanced** section within the **Labor** section.
 - i. Enter description of work activity in the **Description** section (i.e. “Initial Inspection”)
 - i. In the **Equipment** section, select the vehicle from the **Add Equipment** dropdown.
 - j. Add the number of hours for the vehicle.
 - k. Select **Save** on the right side of the screen.
 - l. Close the ELM tab.
3. **Save**, but DO NOT CLOSE the Work Order.

Generating Inspection Findings Reports (Correspondence)

You will use **SSRS Reports** in Cityworks to generate correspondence to the owners of the inspected commercial Facilities. Several Reports have been created, including:

- Notice of Pass-Initial Letter *without* a Corrective Action Form
- Notice of Pass-ReInspect Letter *without* a Corrective Action Form
- 1st Notice of Failure Letter *with* a Corrective Action Form
- Final Notice of Failure-ReInspect Letter *with* a Corrective Action Form
- Final Notice of Failure Letter *with* a Corrective Action Form

These Reports are generated off of the **Current Inspection Status**. All Work Orders that have the reportable inspection status will be included in the report. For example, when the “Send Notice of Pass-Initial” Report is run, it will include all Work Orders with the **Current Inspection Status** of **14 - Send Notice of Pass-Initial**.

How to Utilize the Date Fields to Track Inspection Status

- Projected Start = This **Projected Start** date is the **Work Order** trigger. It is automatically set through the recurring Work Order cycle. It does not change through the lifecycle of the **Work Order**.
- Actual Start = The **Actual Start** date always refers to the date of the Initial Inspection. It should be updated when the initial inspection takes place, in conjunction with recording ELM.
- Projected Finish = The **Projected Finish** date tracks the notification timeclock. For example, if a property owner is given “four weeks” from the date of notification, the **Projected Finish** date

should be set to four weeks after the date the letter was sent. This date is used to trigger the timing for subsequent notifications.

- Note that failure notice dates are also recorded in the “**Commercial Inspection**” category in the **Custom Fields** panel.
- Actual Finish = The **Actual Finish** date refers to the entire inspection procedure and associated notifications. It will only be entered when the Work Order is being closed.

How to Track the Commercial Inspection Process

The Commercial Inspection Process takes several different routes, depending on the inspection results. Each Inbox tracks a group of Work Orders in the same **Current Inspection Status**. You can create a **Report** (letter) to all property owners in the same **Current Inspection Status**.

To send notices to those who passed the initial inspection, follow these steps:

1. Navigate to the **Pass Initial Inspection** Inbox.
2. **Select and Open** all Work Orders in the Inbox.
3. Select **Apply to All** in the **Work Order** panel.
4. Change the **Cur Insp Status** to: **13 – Send Notice of Pass-Initial**.
5. **Save** the Work Order(s).

Cityworks Inbox ▾ Work Order ▾ Request ▾ Inspection ▾ Asset Search ▾ Managers ▾

Work Order Email Print Save **Close** Delete

Work Order

Description:

Number: 13526 (11 Records) Apply To All: ☒

Entity Type: Change

Category:

Initiated By: Date:

Status: Priority:

Requested By: Supervisor:

Submit To: Date:

Projected Start: Projected Finish:

Opened By: Date:

Completed By: GIS Update?:

Closed By: Date:

Actual Start: Actual Finish:

Stage: Expense Type:

Cur Insp Status: **13 - SEND NOTICE OF**

Add Comments:

Select

Existing Comments:

Location Information

WO Address:

Location Details:

Basin: Shop: Maint Zone:

Neighborhood: X Location: Y Location:

Assets

Asset	Asset Id	Asset Uid	Location	Warranty Dat
SWFACILITY	1	96937	19926 19TH AVE NE	
SWCATCHBASIN	2632	CB-3119	19924 19th Ave NE	
SWCATCHBASIN	2633	CB-4572	19924 19th Ave NE Apt 107	
SWCATCHBASIN	2634	CB-4573	19924 19th Ave NE Apt 107	

- Pink rows indicate inventory still under warranty

Map Layer Fields

Reset

6. These Work Orders will now appear in your **Send Notice of Pass-Initial** Inbox.

Create the Notice of Pass-Initial Report

1. Open **Managers → SSRS Reports**.
2. Open **PWORKS Folder**.
3. Select the “**13 – Send Notice of Pass-Initial**” Report.
 - a. The Report will automatically run.
4. Export the letters as a PDF.
5. Print Letters.
6. Once the letters have been printed, open the **Send Notice of Pass** Inbox tab.
7. **Select and Open** all Work Orders in the **Send Notice of Pass** Inbox.
8. Select **Apply to All** in the **Work Order** panel.
9. Change the **Cur Insp Status** to **15 – Notice of Pass Sent**.
10. **Select and Open** all Work Orders in the **Notice of Pass Sent** Inbox.
11. In the **Custom Fields** panel, enter the date the letters were mailed in the **Notice of Pass** field.
Save the Work Order and repeat for each Work Order until all are completed (Apply to All does not work for the Custom Fields).
12. Envelopes need to be generated from this table:
J:\GIS\UTIL\Cityworks\StormwaterFacilityContacts_Open.xlsx

NOTE: The Notice of Pass-Reinspect Report is generated in a similar fashion.

Create the Notice of Fail Report

1. To send notices to those who failed initial inspection, navigate to the **Fail Initial Inspection** Inbox.
2. **Select and Open** all Work Orders in the Inbox.
3. Select **Apply to All** in the **Work Order** panel.
4. Change the **Cur Insp Status** to: **04 – Send 1st Notice of Failure**.
5. **Save** the Work Order(s). These Work Orders will now appear in your **Send 1st Notice of Failure** Inbox.
6. Open **Managers → SSRS Reports**.
7. Open **PWORKS Folder**.

8. Select the **"04 – Send 1st Notice of Failure"** Report.
 - a. The Report will automatically run.
9. Export the letters as a PDF.
10. Print Letters.
11. Once the letters have been printed, open the **Send 1st Notice of Failure** Inbox tab.
12. **Select and Open** all Work Orders in the **Send 1st Notice of Failure** Inbox.
13. Select **Apply to All** in the **Work Order** panel.
14. Change the **Cur Insp Status** to: **05 – 1st Notice of Failure Sent**.
15. Change the **Projected Finish date** in the **Work Order** tab to reflect the allowed response time. Save the Work Orders.
16. This batch of work orders should now appear in your **1st Notice of Failure Sent** Inbox.
17. **Select and Open** all Work Orders in the **1st Notice of Failure Sent** Inbox.
18. In the **Custom Fields** panel, enter the date the letters were mailed in the **1st Notice of Failure** field. Save the Work Order and repeat for each Work Order until all are completed (Apply to All does not work for the Custom Fields).
19. Envelopes need to be generated from this table:
J:\GIS\UTIL\Cityworks\StormwaterFacilityContacts_Open.xlsx
20. Accompanying maps should be updated in GIS, then run as data driven pages. Found in:
J:\GIS\users\Mlvancevich\Commercial
Inspections\Commercial_Facility_Template_Final.mxd
21. Include a Maintenance Contractor List with each fail letter, located here:
G:\PWORKS\OPERATIONS\SWM\Commercial Facilities\4_Vendor
Lists\vactor_contractor_List.pdf

NOTE: The Final Notice of Failure Reports are generated in a similar fashion.

Logging Work Completed

1. When completed Corrective Action forms have been submitted by the owner, update the **Cur Insp Status** and Save the Work Order.
 - a. If work was completed professionally, update the **Cur Insp Status** to **06 – Recd C.A. Notice and Receipt**.
 - b. If work was do-it-yourself, update the **Cur Insp Status** to **07 – Recd DIY-2nd Inspection**.
2. Attach the document from the owner to the Work Order by dragging the icon to the **Attachments** section of the work order.

3. In the **Custom Fields** panel, enter the date the Corrective Action form was received in the **Corrective Action Notice** field. Save the Work Order.

Facility History

You can research the history for a particular facility. For example, you can look up when inspection status changes occurred.

1. Open the Work Order for the Facility you want to track.
2. Click on the dropdown next to Work Order and Select **Audit Log**.

The screenshot shows the Cityworks Work Order interface. The 'Work Order' dropdown menu is open, and the 'Audit Log' option is highlighted with a red circle. The interface includes various panels such as 'Location Information', 'Assets', 'Map Layer Fields', 'Work Cycle', 'Related Work Activities', and 'Inspections'. The 'Audit Log' option is located in the 'Tasks' panel on the left side of the interface.

3. A new window titled Audit Log will open.
4. The history of the **Current Inspection Status** will be visible. For example, in the Audit Log below, on 9/16/2016 at 11:26am, the status of the Work Order was changed from "01 – Initial Notice of Inspection Sent" to "03 – Fail Initial Inspection."

Audit Log - Cityworks - FrontMotion Firefox

cityworks_test.shorelinewa.gov/cityworks_test/WorkManagement/AuditLog.aspx?lightenform=true&TableName=WORKORDER&CWId=9414

Id	Date	Field ▲	Old Value	New Value	Login Name
9414	5/16/2016 11:51:43 AM	RESOLUTION		01 - INITIAL NOTICE OF INSPECTION SENT	MIVANCEVICH
9414	9/16/2016 11:26:30 AM	RESOLUTION	01 - INITIAL NOTICE OF INSPECTION SENT	03 - FAIL INITIAL INSPECTION	MIVANCEVICH
9414	9/27/2016 10:13:30 AM	RESOLUTION	03 - FAIL INITIAL INSPECTION	04 - SEND 1ST NOTICE OF FAILURE	MIVANCEVICH
9414	9/29/2016 11:36:50 AM	RESOLUTION	04 - SEND 1ST NOTICE OF FAILURE	05 - 1ST NOTICE OF FAILURE SENT	MIVANCEVICH
9414	11/3/2016 11:21:48 AM	RESOLUTION	05 - 1ST NOTICE OF FAILURE SENT	06 - RECD C.A. NOTICE AND RECEIPT	MIVANCEVICH
9414	3/13/2017 3:31:03 PM	RESOLUTION	14 - SEND NOTICE OF PASS-INITIAL	06 - RECD C.A. NOTICE AND RECEIPT	MIVANCEVICH
9414	3/13/2017 3:30:22 PM	RESOLUTION	15 - SEND NOTICE OF PASS-REINSPECT	14 - SEND NOTICE OF PASS-INITIAL	MIVANCEVICH
9414	3/13/2017 3:29:28 PM	RESOLUTION	06 - RECD C.A. NOTICE AND RECEIPT	15 - SEND NOTICE OF PASS-REINSPECT	MIVANCEVICH

Appendix L: Property Access Permission Form



Property Access Permission Form

Please complete this permission form and return in the enclosed postage paid envelope to Daniel Sinkovich, City of Shoreline Public Works, 17500 Midvale Avenue North, Shoreline, WA 98133-4905 (phone 206-801-2454).

I, the Owner(s) of the property located at _____,
give permission to the City of Shoreline and/or its contractors the right to enter
upon and to conduct inspections and maintenance of the storm drainage pipe
on my property prior to and after significant rain events or in the event flooding
occurring at nearby properties.

Owner Signature

Print Name

Phone

If you have any special instructions regarding access to your property, please provide details:

Appendix M: Stormwater Drainage Facility Covenant Example

RECORDING REQUESTED BY AND
WHEN RECORDED MAIL TO:

Applicant Name

Applicant Address

Applicant City, State, Zip

**DECLARATION OF COVENANT AND GRANT OF EASEMENT
For Stormwater Best Management Practices**

Grantor(s):

Grantee: City of Shoreline

Tax Parcel ID No.:

Property Address:

Legal Description:

IN CONSIDERATION of the surface water improvements constructed under City of Shoreline Permit No. Permit # relating to the real property described legally described above ("Property"), the Grantor, the owner in fee of the Property, hereby covenants with the Grantee, City of Shoreline, a political subdivision of the state of Washington ("City of Shoreline"), the he/she/they will observe, consent to, and abide by the conditions and obligations set forth herein with regard to the Property and hereby grants an access easement over the portions of the Property to the City of Shoreline for the purposes described herein.

THEREFORE, the Grantor hereby grant, covenant, and agree as follows:

1. The Grantor or his/her/their successor in interest and assigns shall at their own cost, operate, maintain, and keep in good repair the Property's stormwater facilities and/or best management practices ("BMPs") shown on the approved "SITE PLAN" for the property attached hereto as Exhibit B with "DETAILS" sheets attached hereto as Exhibit C. The Property's stormwater facilities and/or BMPs shall be maintained in compliance with the "Operation and Maintenance Requirements" attached hereto as Exhibit A.
2. The City of Shoreline shall have a perpetual access easement over those portions of the Property for the sole purpose of performing inspection and/or monitoring of the stormwater facilities and BMPs and conducting any maintenance or repair activity specified in this Declaration of Covenant.
3. If the City of Shoreline determines that maintenance or repair work is required to be done to any of the stormwater facilities or BMPs, the Public Works Director for the City of Shoreline shall give written notice of the specific maintenance and/or repair work required. In this written notice, the City shall set a reasonable time in which such work is to be completed by the Grantor(s). If the required work is not completed within the time set by the City, the City may perform the required work. Written notice will be sent to the Grantor stating the City's intention to perform the required work. Such notice shall state that the City will not commence any work until at least seven (7) days after mailing of the notice. If, within the sole discretion of the Public Works Director for the City of Shoreline, there exists an imminent or present danger to the public health, safety or welfare, or the

environment, the Grantor hereby waive the seven (7) day notice period and the required work may begin immediately.

4. The Grantor shall assume all responsibility for the cost of any maintenance or repair work completed by the City. Such responsibility shall include reimbursement to the City within thirty (30) days of the receipt of the invoice for any such work performed. Overdue payments will require payment of interest at the prime rate at the time of the work plus two (2) percent as liquidated damages. In the event that City of Shoreline does not receive reimbursement within the required time frame, it may elect to place a lien on the Property and act upon the lien in accordance with the terms and procedures specified in the City of Shoreline Code Title 20, as amended from time to time. If legal action is taken to enforce the provisions of the Paragraph, the prevailing party is entitled to costs and attorney's fees.
5. The Grantor is hereby required to obtain written approval from the Planning and Community Development Services Director of the City of Shoreline prior to performing any alterations or modifications to the stormwater facilities and/or BMPs, except for performance of routine landscape maintenance.
6. Any notice or consent required to be given or otherwise provided for by the provisions of this Declaration of Covenant and Grant of Easement shall be effective upon personal delivery, or three (3) days after mailing by Certified mail, return receipt requested, whichever occurs sooner.
7. This Declaration of Covenant and Grant of Easement is intended to promote the efficient and effective management of surface water drainage on the Property, and it shall inure to the benefit of all the citizens of Shoreline, its successors and assigns. This Declaration of Covenant and Grant of Easement shall run with the land and be binding upon Grantor, and Grantor's successors in interest and assigns.
8. This Declaration of Covenant and Grant of Easement may be terminated by execution of a written agreement by Grantor and the City of Shoreline expressing their mutual agreement to terminate this Declaration of Covenant and Grant of Easement.

____ day of _____, 20____.

By _____

Its _____

By _____

Its _____

STATE OF WASHINGTON)

) ss.

COUNTY OF KING)

I certify that I know or have satisfactory evidence that _____ is the person(s) who appeared before me, and acknowledged that he/she/they signed and delivered this instrument as his/her/their free and voluntary act for the uses and purposes set forth.

Dated this _____ day of _____, 20____.

Notary Public in and for the State of Washington,

Residing at _____

My commission expires _____

EXHIBIT A
OPERATION AND MAINTENANCE REQUIREMENTS

MAINTENANCE REQUIREMENTS

Your property contains stormwater management BMPs (best management practices) called
" , " , " , "
which were installed to mitigate the stormwater quantity and quality impacts of some or all of the
impervious surfaces on your property. The size, placement, composition, and downstream flow
paths of these devices as depicted by Exhibit B Site Plan and Exhibit C Details must be maintained
and may not be changed without written approval from the City of Shoreline or through a future
development permit from the City.

Appendix N: Surface Water Hot Spots

Table N1 lists the City of Shoreline Hot Spot locations inspected during and after storms as of 12/28/2017.

Table N-1. Seasonal and Storm Triggered Hot Spot Inspection Locations				
Asset ID	Name	Concern	Location	Operated By
HS-1	Pan Terra Pump Station	Susceptible to debris on grates	18500 DAYTON AVE N	City-Regional
HS-2	Hillwood Park	Susceptible to debris buildup on fence and culvert	336 NW 189TH ST	City-Parks
HS-3	8th NW	Susceptible to localized flooding	NW 191ST PL & 8TH AVE NW	City-ROW
HS-4	Storm Creek Crossing	Susceptible to debris buildup on grate	17TH PL NW & 16TH AVE NW	City-Regional
HS-5	Springdale CT Catch Basins	Inspect catch basins for debris	18532 SPRINGDALE CT NW	City-ROW
HS-6	Hidden Lake	Inspect outfall	1005 NW 166TH ST	City-Regional
HS-7	Shoreview Pond, outfall	Inspect outfall	401 NW 175TH ST	City-Regional
HS-8	Boeing Creek M1 Dam	Inspect outfall	NW 171ST ST & 2ND AVE NW	City-Regional
HS-9	Palatine Place	Infiltration / Capacity problems	15508 PALATINE LN N	City-Regional
HS-10	Linden Ave Pump Station	Susceptible to debris on grates	749 N 148TH ST	City-Regional
HS-11	Interurban trail	Susceptible to debris buildup on grate	15310 LINDEN AVE N	City-Regional
HS-12	Darnell Park	Susceptible to debris buildup on grate	1125 N 165TH ST	City-Regional
HS-13	Mr. VanGard Storage	Capacity issues	N 178TH ST & MIDVALE AVE N	City-ROW
HS-14	Cromwell Park	Outfall susceptible to leaf build up	18006 MERIDIAN AVE N	City-Regional
HS-15	Echo Lake, outfall	Inspect outfall	19815 ASHWORTH AVE N	City-Regional
HS-16	North Ridge	Inspect culvert	NE 200TH ST & 6TH AVE NE	City-ROW
HS-17	Ballinger Park Creek	Inspect outfall	19857 25TH AVE NE APT 301	City-Regional
HS-18	KC Construction Yard	Susceptible to localized flooding	19553 25TH AVE NE	City-ROW
HS-19	McAleer Creek R/D Pond	Inspect outfall	1661 NE 195TH ST	City-Regional
HS-20	12th Ave NE Ditch	Keep trench on south side of ditch open.	19211 12TH AVE NE	City-ROW
HS-21	Shoreline Eastern Border	Susceptible to debris buildup	17721 25TH AVE NE	City-ROW
HS-22	Pump Station 26	Capacity problems	18351 10TH AVE NE	City-Regional
HS-23	Serpentine Pump Station	Capacity issues	5TH AVE NE & NE 178TH ST	City-Regional
HS-24	Pump Station 25	Localized flooding	17738 2ND PL NE	City-Regional
HS-25	Catch Basin	Susceptible to localized flooding	110 NE 174TH ST	City-ROW
HS-26	NE 175th St.	Capacity problems	17408 10TH AVE NE	City-Regional
HS-27	10th NE	Susceptible to localized flooding	17100 10TH AVE NE	City-ROW
HS-28	Ghezzi Pond	Capacity issues	17029 11TH AVE NE	City-ROW
HS-29	Pump Station 30	Capacity problems during power outage	1241 NE 170TH ST	City-Regional
HS-30	Ronald Bog Drainage	Inspect outfall	CORLISS AVE N & N 172ND ST	City-Regional
HS-31	196th NW	Susceptible to debris on grates	26TH AVE NW & NW 196TH ST	City-ROW

Appendix O: Integrated Mosquito Management Plan

Appendix O

Integrated Mosquito Management Plan

Mosquito-borne diseases pose both human-health and ecological risks. Mosquitoes have always been potential vectors for diseases, and West Nile Virus became an increasing concern after it was first detected in the eastern United States in 1999. The virus spread rapidly to the West Coast. The following presents the Integrated Mosquito Management Plan (IMM) for the City of Shoreline (City).

Introduction

As a facility owner/operator, employer, drainage system owner/operator, and municipality, the City can help manage the risk of West Nile Virus by initiating efforts to minimize mosquito breeding habitat, control mosquito larvae in City facilities when the City determines it is appropriate, and educate City employees about personal protection.

The City will expect and rely on the Public Health – Seattle and King County and Washington State health departments to perform primary surveillance and primary public education and outreach functions for the purposes of general public health.

All mosquito management activities must comply with the requirements of the current version of the *Aquatic Mosquito Control General Permit* (Ecology 2015), National Pollutant Discharge Elimination System (NPDES), and State Waste Discharge General Permit issued by the State of Washington Department of Ecology (Ecology).

Plan Objectives

This Integrated Mosquito Management (IMM) plan has two main objectives:

- To adequately control adult mosquitoes while minimizing the incidental discharges to waters of concern
- Document the decision process of where, when, and how mosquito control is implemented within a Permittee's permit coverage area.

General Information

Contact Information

For information regarding this plan please contact:

Uki Dele, P.E.
Surface Water & Environmental Services Manager
(206) 801-2451
udele@shorelinewa.gov

This plan covers all areas included within the city limits of Shoreline, as delineated on Figure 1.

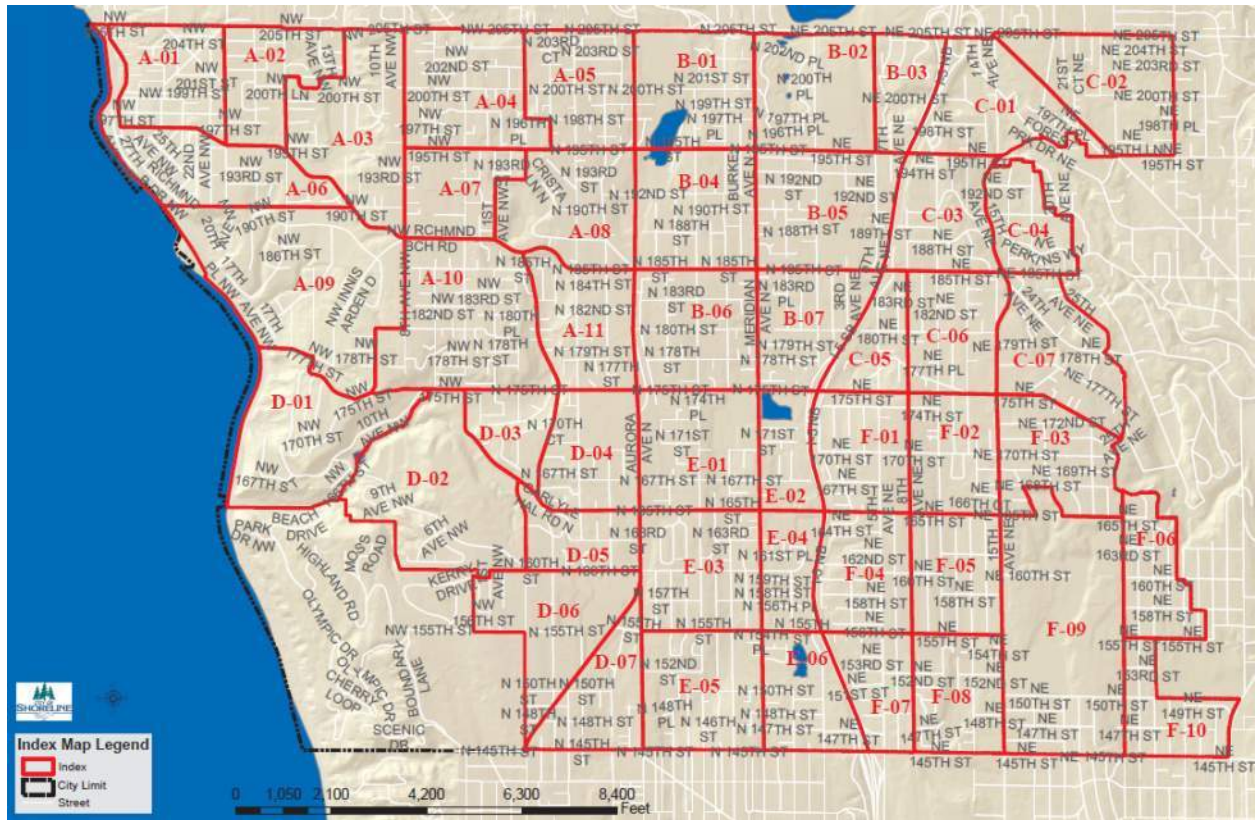


Figure 1. Shoreline City Limits

Emergency Reporting. In the case of emergencies such as pesticide exposure or spills to waters of the state, the City will implement the following plans;

- Spill Response Plan as documented in <http://www.shorelinewa.gov/government/departments/public-works/surface-water-utility/services/spill-response>

Surveillance

Two primary surveillance techniques may be used to control the local mosquito population including:

- Larval Mosquito Surveillance. At the time this plan was prepared, the City is not required to perform pretreatment surveillance. Information regarding the threat from mosquito-borne disease can be viewed on King County's website at: <http://www.kingcounty.gov/depts/health/communicable-diseases/disease-control/west-nile-virus/mosquito-control.aspx>

If it is requested by citizens who reside within the direct treatment area, the City will conduct post-larviciding surveillance to determine the effectiveness of the larvicide.

- Adult Mosquito General Surveillance. To determine whether pesticides used to control adult mosquitoes (adulticides) may be applied, the City may use a variety of procedures. Citizen reports will be recorded to identify potential sites. When a sufficient number of reports have been received, the City will conduct firsthand surveillance at the potential site. The City will also evaluate whether a site is a high-priority area due to regular high usage or planned outdoor events. Finally, the City will take into account whether a potential site has a history of excessive mosquito populations.

Mapping

The City uses a variety of mapping techniques, as appropriate, in an effort to control mosquito populations including:

- **Mosquito breeding sites:** The City employs a GIS database to record locations where high mosquito activity has been identified. The City also keeps records of complaints made by citizens in order to track historical and new breeding sites.
- **No-spray zones:** There are no known areas that need to be avoided when spraying adulticides. However, the City will always take into consideration any citizen request for a no-spray zone.
- **Endangered species critical habitat:** The City will rely upon the National Oceanic and Atmospheric Administration, Ecology, Environmental Protection Agency (EPA), and Washington Department of Fish and Wildlife (WDFW) in circumstances in which any species listed under these authorities are present.
- **Other relevant information:** This section will be updated if other relevant information becomes apparent.

Action Thresholds

1. Larval Mosquito Action Thresholds

The City may choose to apply larvicide if any of the following threshold conditions are met:

- a. The City conducts pretreatment surveillance of a potential larvicide application site and finds at least one larvae/pupae in at least one of three dips. In the event that the City finds larvae/pupae, and the area is treated, the City may continue preemptive larvicide treatments without dipping for the remainder of the treatment season.

- b. The Permit Area includes intermittently flooded areas that have a historical record of mosquito hatches following flooding. In that event, the City may use Methoprene as a pre-emergent dry-land treatment in those areas without pretreatment dipping.
- c. The City has developed and obtained Ecology approval of a large-site sampling protocol prior to treatment.
- d. The application site is in, or adjacent to, a county in which mosquito, bird, animal, or human mosquito-borne disease cases are confirmed during the current treatment season.
- e. The treatment site is a catch basin, storm drain, or utility or transportation vault.
- f. State or local health authorities declare a public health threat or emergency related to mosquito-borne disease.

2. Adult Mosquito Action Thresholds

The City considers a variety of factors when determining whether to apply adulticides. These factors include citizen reports, firsthand surveillance, whether the site in question is a high-traffic public area, whether large events have been planned for the site, and if the site has a history of mosquito problems.

Adulticiding is generally less effective than the methods to control larvae, as described above. Adulticiding may be considered when there is a severe nuisance problem to provide relief from heavy swarms of biting mosquitoes or when public health officials have determined that the risk from mosquito-borne diseases outweighs the potential risks from the use of adulticides.

The City will rely on the expertise of the Seattle - King County Health Department and Washington State Department of Health in determining when the nuisance is severe enough to provide relief from heavy swarms of biting mosquitoes or when public health officials have determined that the risk from mosquito-borne diseases outweighs the potential risks from the use of adulticides. If the city chooses to use a licensed contractor the City will rely on the contractor's professional judgment for surveillance and action thresholds.

Mosquito Control Methods

The City will use a variety of mosquito control methods in its permit coverage area. The City's primary focus will be physical control and source reduction. Some approved forms of biological controls and larvicide will be used, and adulticide will be employed as a last resort, primarily in city parks. The City will also focus on educating the public about eliminating standing water to reduce mosquito breeding sites, since most of the property in the permit area is not owned or maintained by the City.

1. Physical Control and/or Source Reduction

The City employs propane traps as a physical control for mosquitoes. These traps are maintained by the Parks Department at the beginning of each mosquito season. To reduce sources for mosquito breeding, all City-owned facilities are regularly examined to eliminate standing water wherever possible.

2. Biological Mosquito Control

The City uses *Bacillus thuringiensis israelensis*, commonly known as Bti. This is a natural mosquito control product that does not harm other wildlife, is easy to apply, and kills larvae quickly and efficiently. The City also uses Altosid, which contains (S)-Methoprene, an insect growth regulator (IGR) that stops mosquitos from becoming breeding, biting adults. (S)-Methoprene is target-specific, and will not affect fish, waterfowl, mammals or beneficial predatory insects. In addition, the City also encourages property owners to install bat houses as a means of mosquito control.

3. Pesticide-Based Larval Mosquito Control

- a. Allowed larvicides: Appendix 1 includes labels for all larvicide products that will be used by the City and those that are allowable in the permit.
- b. Equipment calibration and maintenance: Pesticide application equipment will be maintained in proper operating condition, including calibration, cleaning, and repair. This work will be performed by a licensed contractor on a regular basis with the exception of the propane traps, which will be maintained by the Parks Department staff.

4. Pesticide-Based Adult Mosquito Control

- a. Allowed adulticides: Appendix 1 includes labels for all adulticide products that will be used by the City and those allowable in the Permit.
- b. Equipment calibration and maintenance: Pesticide application equipment will be maintained in proper operating condition, including calibration, cleaning, and repair. This work will be performed by a licensed contractor on a regular basis.

Monitoring for Efficacy/Resistance

The City will monitor pesticide resistance through GIS tracking of application sites and records from citizen reports.

Record-Keeping and Reporting

Annual Report The City will submit the required Annual Report by December 31 each year in both electronic and hard-copy formats. For more details and to see a template of this report, please refer to Appendix 2

Noncompliance Notifications

In the event that the City violates or is unable to comply with any permit condition, the City will immediately take action to minimize potential pollution or otherwise stop the noncompliance and correct the problem.

The City will also provide a written report to Ecology per the requirements of this permit. These requirements are detailed in Section S8.D of the Mosquito Control Permit. Finally, the City will update its IMM plan to address the noncompliance to reduce the likelihood of the incident occurring again.

Education and Outreach

The City of Shoreline conducts a number of public outreach and education activities. Among these, the City contributes articles to local newspapers providing information about source reduction, encourages landowners to invest in biological controls such as bat houses, and holds in-field educational opportunities for citizens.

New Staff Training and Continuing Training for Existing Staff

City staff receive regular Illicit Discharge Detection and Elimination (IDDE) training to ensure property detection and response in the event of a spill. When necessary, the City contracts pesticide application to licensed contractors and ensures that contractors are certified and licensed in aquatic pest control.

Signature Requirements

"I certify under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering information, the

information in the IMM is, to the best of my knowledge and belief, true, accurate, and complete and will be updated as necessary. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations. Unless the Department of Ecology Permit has more stringent requirements, all FIFRA label directions and requirements will be followed.”

[INSERT SIGNATURE BLOCK FOR RESPONSIBLE STAFF]

Public Access to IMM Plans

The City of Shoreline shall provide access to the IMM plan to the public through the City’s website.

Notification to Public

The City of Shoreline shall provide public notice of mosquito control activities at least 10 days before the first pesticide application of the season. The City shall do one of the following:

- 1) Provide public notice on the City’s website and distribute the notice to identified parties through email or other electronic means.
- 2) Publish a public notice in a newspaper with general circulation within the area where the larvicides or adulticide application will take place.

The Notice will include:

- a) The pesticide(s) planned for use and the active ingredient(s).
- b) The approximate date ranges of planned treatments.
- c) The approximate treatment location(s).
- d) The online location where the public may find pesticide application updates (if available online).
- e) The application area posting procedures if the use of the larvicides with water-use restrictions is planned.
- f) The name and telephone number of the Aquatic Pesticides Permit Manager.
- g) The telephone number, email address or website where a person may contact to have their name put on a “No Spray” list.

Appendix 1 - Active Ingredients Authorized for Use

1. Bacillus sphaericus (H-5a5b)
2. Bacillus thuringiensis israelensis (Bti)
3. Malathion
4. Methoprene
5. Monomolecular Surface Films (MSF)
6. Paraffinic White Mineral Oil
7. Spinosad
8. Temephos
9. Etofenprox
10. Naled
11. Natural Pyrethrins
12. Permethrin
13. Piperonyl Butoxide (PBO)
14. Prallethrin
15. Resmethrin
16. Sumithrin (d-phenothrin)

Appendix 2 - Annual Report

By December 31 of each year, the Permittees must submit an annual report electronically through Ecology's online data management system (Secure Access Washington at

<https://secureaccess.wa.gov>. A signed and dated hard copy of the annual report must also be mailed to:

Department of Ecology

Water Quality Program

Attn: Aquatic Pesticide Permit Manager

PO Box 47696

Olympia, WA 98504-7696

The annual report must include:

- a. Permit Number.
- b. Permittee Name.
- c. Name of the location treated. The location is the area for which the Permittee has permit coverage for (e.g., ABC Golf Club, ABC City storm drain system, ABC County, ABC Mosquito Control District).
- d. Total amount of each active ingredient applied during the season in pounds.
- e. Whether treatment occurred in areas identified as vulnerable species habitat
- f. Total amount of each active ingredient applied during the season in pounds to areas identified as vulnerable species habitat.

Appendix P: Spill Response Plan

Appendix P

Spill Response Plan

1.0 Overview

It is the City of Shoreline's obligation under the NPDES Phase II Western Washington Municipal Stormwater Permit to provide spill prevention, spill response planning and training, and spill cleanup. This spill response manual provides City staff with basic information on how to respond to spills.

The primary goal of this spill response plan is to prevent contaminants from entering the storm drain system and local waterways. Spills of this nature typically have the potential to be more mobile in the environment and cause a greater threat to human health and the environment. However, releases to land and water also require cleanup and proper notification.

The spill response plan provides guidance to City of Shoreline staff who may respond to spills. Three levels of response are outlined in the plan. Staff are responsible for placing themselves in the proper response level category based on their job description, their likelihood of encountering a spill in the field, and experience with spills. **All** staff are responsible for reporting any spill encountered in the field or that they may have caused. The other two response levels involve spill containment and cleanup. Only qualified staff should perform those activities.

Spill containment and clean up may require assistance from other agency staff, depending on the nature of the material spilled and the size of the spill. Generally, if a spill is larger than a 1 gallon or over 1-pound, or is a hazardous substance, other agencies or city departments will need to be notified. If the spill is smaller than that, not hazardous, and not entering a storm drain or waterway, you may clean up the spill yourself, and reporting is not required. You may always contact Surface Water and Environmental Services (SWES) staff for advice or disposal assistance regardless of size.

In addition to this manual, appropriate staff shall receive spill response training from the City of Shoreline Water Quality Specialist or other SWES representative. Staff should familiarize themselves with this manual to ensure a coordinated approach while responding to spills. Use of this manual is intended to decrease the inherent risk to those responding to the spill and to surface waters within the City of Shoreline.

2.0 What is a Spill?

The Environmental Protection Agency generally describes a spill as an accidental or intentional discharge of chemicals, hazardous substances, or petroleum product which has the potential to contaminate bodies of water, soil, underground water sources or get into storm and sewer systems.

A "spill" is any unauthorized discharge. The term "hazardous materials" referred to in this plan includes all types of petroleum products related to vehicles (gasoline, diesel, motor oil, brake fluid, transmission fluid, etc.) and other liquids and solids that pose a threat to human health and the health of the environment. The most common non-petroleum materials are anti-freeze and pesticides (herbicides, insecticides, and fungicides).

3.0 Types of Incidents

Generally, there are two classes of spills that will be encountered in the field or found when City employees arrive at a site:

- 1) Emergency Spill – Spills of high-risk nature (hazardous or unknown material, large quantity or any time that the contaminant discharges from the City system into a receiving water body). There is an imminent danger to the public and/or the environment. This applies to spills within the right-of-way or on private property.
- 2) Incident (non-emergency) Spill
 - a. City Right-of-Way – Spills of low-risk nature (identifiable material and small quantity). These spills can be contained and cleaned up by the City (or its Contractors). If a known private party is responsible for the spill, this party shall be billed any clean up cost incurred by the City.
 - b. Private Property – Spills of low-risk nature (identifiable material and small quantity). City will assist to prevent entry of material into the public drainage system, followed by thorough cleanup by the responsible party.

4.0 Staff Response Level

The response levels below are general guidelines. Your personal safety is always the first priority. City staff are responsible for determining the level that best fits the description of their job position, comfort level and experience. Level 1 is the minimum level that must be performed by all staff.

Response Level	Description of Staff	Action
Level 1	<ul style="list-style-type: none"> Staff with a low probability of encountering a spill in the field or within City limits. Generally, have not encountered a spill before and are not comfortable performing any kind of containment or cleanup activities. Examples of level 1 staff include PADS Planners, City Clerks, Spartan Gym Parks staff, most Managers, and City Administration staff. 	Assess Report/call <ul style="list-style-type: none"> Call 911 immediately if it is an emergency. Always notify CRT, SWES, and ROADS staff of the spill.
Level 2	<ul style="list-style-type: none"> Staff with a moderate probability of encountering a spill in the field or within City limits. Generally, staff have had some previous exposure to spills and are somewhat comfortable with containment or cleanup activities. Examples of level 2 staff include Traffic Engineer/ Technicians, Right-of-Way Inspectors, Facilities, Police, and Parks Maintenance staff. 	Assess Report/call <ul style="list-style-type: none"> Call 911 immediately if it is an emergency. Always notify CRT, SWES, and ROADS staff of the spill. Contain and Cleanup <ul style="list-style-type: none"> Contain the spill and secure the scene <i>if comfortable</i>. Begin cleanup activities <i>if comfortable</i>.
Level 3	<ul style="list-style-type: none"> Staff with a high probability of encountering a spill in the field or within City limits. Spill response is part of their job duty. Generally, staff have had moderate or frequent exposure to spills and are comfortable with containment or cleanup activities. Examples of level 3 staff include Roads, CRT, and SWES staff. 	Assess Report/call <ul style="list-style-type: none"> Call 911 immediately if it is an emergency. Always notify SWES staff of the spill. Contain and Cleanup <ul style="list-style-type: none"> Contain the spill and secure the scene. Begin cleanup activities if comfortable. Procure outside cleanup assistance if needed.

Making notifications in the case of the spill is primarily the responsibility of SWES staff. However, if SWES staff cannot be reached and immediate action is necessary, this document will provide CRT, Roads, or other qualified City staff with the information needed to make the contacts on the behalf of SWES.

5.0 Spill Response Steps

This section outlines the steps that should be taken by the first **City-representative** that arrives at the scene of a spill or the City staff person responsible for the spill. Take the actions outlined according to your appropriate response level.

You may not be the first person on the scene (for example, in the case of a spill caused by a contractor or resident) but as a City representative you shall notify the appropriate City staff (see section 5.2.1 for contact phone numbers) and verify that cleanup procedures are being generally followed by the responsible party.

For any type of spill response, ***providing for the safety of the public and activation of other emergency services is first priority***. When you arrive at a spill scene and you find an emergency situation, call 911 and ask to be transferred to the Shoreline Fire Department so they can assess the situation and call for a HazMat team if needed. Always report a spill, except a small spill of non-hazardous material less than 1 gallon, to SWES, CRT, or ROADS staff and take the appropriate steps according to your staff response level.

1. Obtain Information about the Incident
2. Notify the Appropriate Authorities
3. Secure the Scene
4. Contain the Spill
5. Cleanup the spill and document the Cleanup efforts

Details of each step are provided in the sections below.

For major spills, follow these steps closely. For minor spills, choose the steps necessary to protect human health and the environment and to expeditiously clean up the spill. In most cases, it may be necessary to perform the steps out of order in order or simultaneously to protect human health and the environment (for example, containing the spill prior to notifying the appropriate authorities).

5.1 Obtain information About the Incident

This information will be relayed to the appropriate regulatory agencies.

- Your name, location, organization, and telephone number
- Name and address of the party responsible for the incident
- Date and time of the incident
- Weather conditions at the incident location
- Location of the incident
- Source and cause of the release or spill
- Types of material(s) released or spilled
- Quantity of materials released or spilled (See **Appendix C** to estimate the quantities of oil in water)
- Danger or threat posed by the release or spill
- Number and types of injuries (if any)

This information should be entered in to Cityworks, but can be summarized in the Hazardous Materials Spill Report Form located in Appendix A if you do not have immediate access to Cityworks.

Always take photographs of the incident if possible as part of the documentation process. Use your best judgment to get as accurate information as possible.

5.2 Notify the Appropriate Authorities

When a spill occurs, the appropriate authorities must be notified. The appropriate notifications depend whether the spill is classified as an emergency or non-emergency. Please review Section 3.0 of the Spill Response Plan for the definition of each type of spill if you are unsure. Make contact with proper authorities immediately after arriving on scene.

If the spill is classified as an emergency, first call 911 and ask to be transferred to the Shoreline Fire Department so they can assess the situation and call for a HazMat team if needed. After you have called 911, immediately notify the City's CRT, SWES, and ROADS staff.

For incident (non-emergency) spills, the City's SWES or CRT staff must be notified.

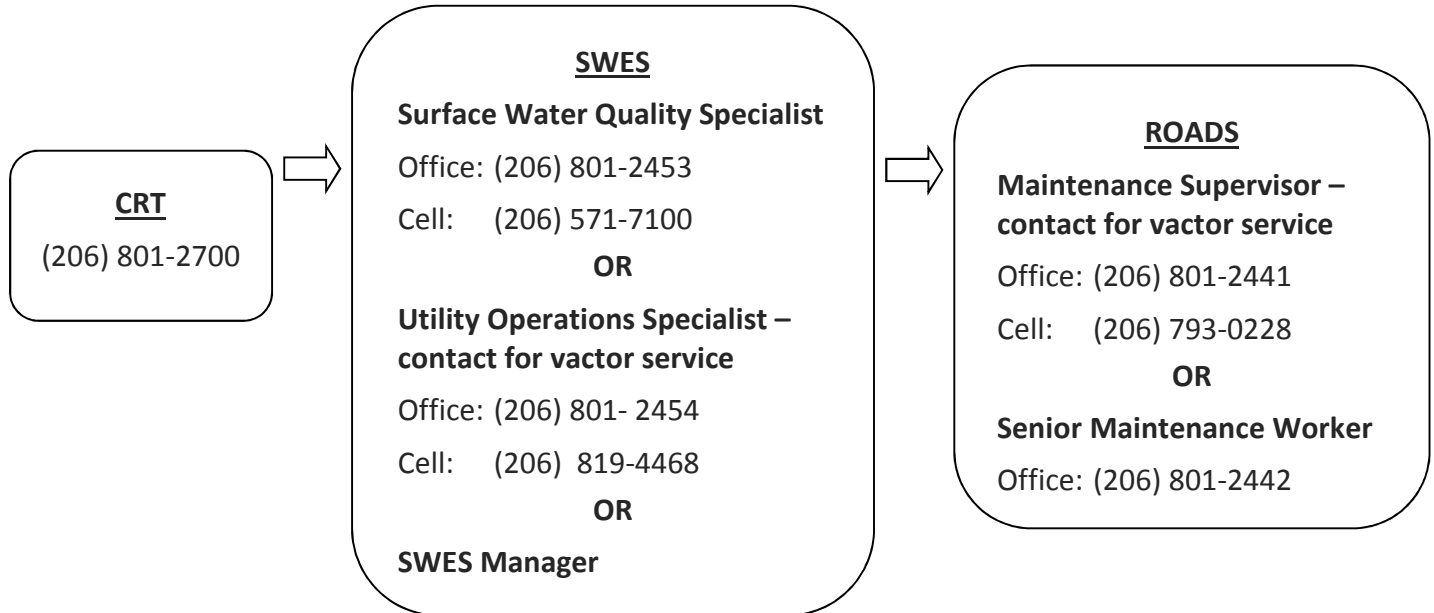
Telephone numbers are provided in section 5.2.1 below, as well as in Appendix B, the Spill Response Notification Flow Chart.

It will be the responsibility of the City's SWES staff to report the spill to additional agencies if necessary.

5.2.1 Contact List

IF THERE IS AN IMMINENT THREAT TO HUMANS OR THE ENVIRONMENT, IMMEDIATELY CALL 911.

Also, for all emergencies and incidents, contact:



If unable to notify CRT, SWES, or ROADS, call:

Washington Department of Ecology Northwest Region 24-hour response: (425) 649-7000.

If unable to notify, respond to spill with persons and equipment on hand and call:

Ventilation Power Company¹: (206) 634-2750

- Only call Ventilation Power if it is an imminent threat to public health and/or the environment (e.g. oil is entering the storm drain).
- Ventilation Power can bring a vactor truck to vacuum up large quantities of free product from the stormwater system. In some cases they can skim product off of the water. Call them and describe the site, nature of the spill (product and quantity) and cleanup requirements. They will tell you if they have the capability to respond.

Washington Department of Ecology Northwest Region 24-hour response: (425) 649-7000

Call the Department of Ecology (DOE) Northwest Regional Office's Emergency Reporting Tracking System (ERTS) 24-hour response and describe the site, nature of the spill (product and quantity) and cleanup requirements. Inform them that the City is unable to respond to the spill and outside assistance is needed.

National Response Center: (800) 424-8802

If the spill is large-scale, call the National Response Center after reporting to the Department of Ecology.

5.2.2 NPDES Required Notifications

Any time there is a spill or discharge into or from the City's stormwater drainage system that *poses a threat to human health, welfare, or the environment*, the City's NPDES permit requires that the proper authorities be notified. The table below outlines the conditions in which notification is necessary and provides the phone numbers to call.

Type of Discharge	Who to Notify	Time to Notify	Special Reporting
A spill or discharge into or from my MS42, which could constitute a threat to human health, welfare, or the environment.	Ecology Northwest Regional Office: (425) 649-7000	Immediately, but no later than 24- hours after obtaining the knowledge.	Notify jurisdictions, or secondary permittees, with inter-connected MS4s as needed.
A spill or discharge of oil or hazardous substances into or from my MS4, which presents a threat to human health, welfare, or the environment.	Ecology Northwest Regional Office: (425) 649-7000 AND Washington Emergency Management Division: (800) 258-5990 OR (800) OILS-911 AND National Response Center: (800) 424-8802	Immediately	None
A spill or discharge into or from my MS4, which might cause bacterial contamination of shellfish. (Western Washington only)	Ecology Northwest Regional Office: (425) 649-7000 AND WA State Department of Health: (360) 236-3330	Immediately	None

¹ Ventilation Power Company is the Surface Water Utility's current on-call contractor – this information will be updated if the on-call contractor changes.

² The NPDES permit refers to City's storm drainage system as a MS4 (municipal separate storm sewer system).

5.2.3 Resource Impact Notification Requirements

If the spill impacts resources **in addition** to water or soil, the proper agencies shall be notified. Below are the necessary contacts based on the resources impacted.

Resources Impacted	Agency to Notify	Phone Number
Air Quality	Puget Sound Clean Air Agency Complaint Hotline	(800) 552-3565 Extension 6
Fish and Wildlife	Washington Department of Emergency Management	(800) 258-5990
Puget Sound (for large spills)	US Coast Guard Seattle district command center	(206) 220-7001
Drinking Water – East of I-5	North City Water District	(206) 362-8100
Drinking Water – West of I-5	Seattle Public Utilities District	(206) 386-1800
Sewer (also for spills caused by sewage overflow)	Ronald Wastewater Management	(206) 546-2494 (After hours emergency: (206) 533-0177)

5.3 Secure the Scene

- Keep all persons as far away from the incident as is practical. If necessary to take actions to control traffic and protect motorists, contact the Shoreline Police at 911 or City staff trained in appropriate traffic control procedures.
- Observe and size-up the incident from a safe distance. Providing rescue and first aid shall be at the employee's discretion.
- Avoid contact with spilled material and avoid breathing vapors, smoke, or dust originating from the material.
- Stay upwind of any fires and spills; keep out of low areas.
- Do not clean up any unfamiliar, unknown, or suspected hazardous material. Avoid spreading contamination (i.e., liquids, solids, or gases).
- Call for additional City resources to secure the scene or to help with the other aspects of the spill response.
- Obtain names and contact information and encourage all persons involved with the incident to remain at the scene. If detention is necessary, please call 911 for the Shoreline Police.

5.4 Contain the Spill

- If safe, stop the source of the spill and keep the spilled substance from migrating away from the source using spill kits or other appropriate equipment, to the extent practicable.
- Prevent the spilled material from entering storm inlets (catch basins) and entering sanitary sewer lines.
 - Confine the spill and direct flow away from drains, streams, and wetlands by using absorbent booms, sandbags, or berms.
 - Block off storm or sewer inlets with sandbags or a rubber drain cover mat if available.

More information on spill containment and cleanup can be found in section 6.0 of this document.

5.5 Cleanup the Spill and Document the Cleanup Efforts

Proper clean-up procedures are described in section 6.0 below. Document how the spill was cleaned up (absorbent pads, booms, vacuor truck, etc.). You must also document where the cleaned up material was disposed. All this information, as well as the information collected in step 1 (obtain information about the incident), should be documented in Cityworks.

6.0 Spill Cleanup

The following procedures describe the steps to cleaning up a spill.

6.1 Spill Response Equipment - Spill Response Kit

Your vehicle may be equipped with a spill response kit. Vehicles typically driven by Level 2 staff are equipped with a 5-gallon response kit at a minimum. Vehicles for Level 3 staff are generally equipped with a spill kit capable of containing and cleaning up larger spills. There may also be a spill kit on site (for example: there is a spill kit on site for the generator at the Spartan Gym).

A spill kit is typically contained in a yellow bag or container and contains absorbent materials (granular, pads, and booms) and PPE (gloves and safety glasses). Below are the typical spill kit contents that you will find in the City Vehicles for Level 2 and 3 staff.

- Level 2 - General spill kit contents (for a spill kit that absorbs up to 3 gallons) are:
 - Instruction sheet
 - 1 pair Nitrile gloves
 - 2 - 3" x 4' socks
 - 10 - 16" x 20" pads
 - 1 disposal bag
- Level 3 - General spill kit contents (for a spill kit that absorbs up to 15 gallons) are:
 - 1 emergency response book
 - 1 pair Nitrile gloves
 - 1 pair goggles
 - 3 - 3" x 4' socks
 - 2 - 3" x 10' socks
 - 20 - 17" x 19" pads
 - 1 disposal bags/ties
 - SPAGH SORB® or other granular absorbent (optional)
 - Absorbent products contained in the spill kits, besides granular absorbents, are colored according to the type of material they are effective for:
 - White absorbents are hydrophobic (do not absorb water) and attract oil. They are good for skimming product off of the water surface and absorbing oil off of hard surfaces.
 - Grey or light green absorbents are multi-purpose, good at soaking up almost everything, including water. Use these when cleaning up spills that are not in water.
 - Pink absorbents - the City does not generally use pink absorbents, but if they are available they are specially treated to soak up the widest range of corrosive liquids (acids or bases) or unknown liquids. They are good for cleaning up chemical spills.

Please contact SWES for information about obtaining a spill kit or the replenishment of spill kit contents.

6.2 Spill Cleanup Procedures

Important: Always follow these safety precautions:

- Wear appropriate personal protective equipment at all times.
- Do not enter confined spaces!
- Do not enter trenches or excavations, buildings in danger of collapse, and areas with strong vapor, chemical clouds, or odor.
- Do not smoke or eat during cleanup.
- Always wash your hands after cleanup.

6.2.1 Released On Land

6.2.1.1 Impervious Surface (e.g., asphalt, concrete, tile)

Place SPHAG SORB® or granular absorbent on the product, being sure to cover all wet areas. When as much of the product has been absorbed as possible (it may have to be left on the spill a while to absorb all of the product), sweep up the absorbent, place inside of a trash bag and seal the bag.

6.2.1.2 Soil

Contaminants that enter soil are not generally mobile and will not further contaminate surrounding areas. When there is a release of a contaminant to the soil, please contact SWES and staff will determine the best course of action for cleanup.

6.2.2 Release to water

6.2.2.1 Flowing In a Stream of Water on the Pavement into a Ditch or Storm Drain

Place white absorbent pads or booms, as appropriate, at the source of the contaminants to skim them off of the surface of the water and prohibit the flow of the contaminants from the source. Follow the flow of contaminants downstream to the first ditch, catch basin or receiving water body you come to (receiving feature). Place absorbent pads or booms at the point where contaminants are flowing into a receiving feature. Also place absorbent pads inside the receiving feature, as necessary, to remove as many contaminants as possible. These absorbents typically need to be left at the scene for an extended period of time in order to capture as much of the contaminants as possible. When the absorbents become saturated, or a spill has been completely contained, pick up the absorbents, place them inside a plastic bag and seal the bag.

See Section 6.2.3 below for disposal instructions.

6.2.2.2 In a Stream or Lake

If the spill enters into a water body, immediately contact SWES, CRT, or ROADS. They will respond immediately to the scene. Please begin cleanup procedures while you are waiting for their arrival.

If the spill was not directly into the water body, follow the cleanup instructions provided in Section 6.2.2.1 AND take the following actions:

- For spills directly into a water body, place, if safe to do so, white absorbent pads or booms on the spill to skim the contaminants from the surface of the water. Leave these absorbent materials in place until SWES, CRT, or ROADS staff arrives on scene.

6.2.3 Disposal of Cleanup Materials

Dispose of the absorbent materials in an appropriate manner consistent with the nature and volume of the spill and consistent with State law. In most instances, small quantities of materials can be sealed inside a plastic bag and placed in a solid waste container.

If you are unsure of the proper disposal method please contact SWES, CRT, or ROADS and they will advise you.

Several hard copies of this plan are available with Surface Water and Environmental Services, the Customer Response Team, and Roads.

7.0 Appendices

Appendix A. Hazardous Materials Spill Report Form

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HAZARDOUS MATERIALS SPILL REPORT FORM

NOTE: COMPLETE THIS FORM ONLY IF YOU ARE UNABLE TO COMPLETE A SERVICE REQUEST IN CITYWORKS.

1. Location: _____ **2. Date/Time:** _____

3. Person Reporting Spill: _____

4. Person in Charge On Scene: _____ **5. Phone:** _____

6. Material(s) released: _____ **7. Quantity:** _____

8. Weather conditions at time of Spill: _____

9. Source/Cause of Spill:

10. Describe Any Injuries or Potential Threats to Human Safety:

11. Contamination of: soil _____ water bodies _____ drains _____ streets _____

plants _____ people _____ vehicles/equipment _____ other (explain) _____

12. Estimated Affected Area: _____

13. Name and Contact Information of Responsible Party for Spill and Cleanup:

14. List Any Other Entities or Agencies Involved in the Cleanup (contractors, etc):

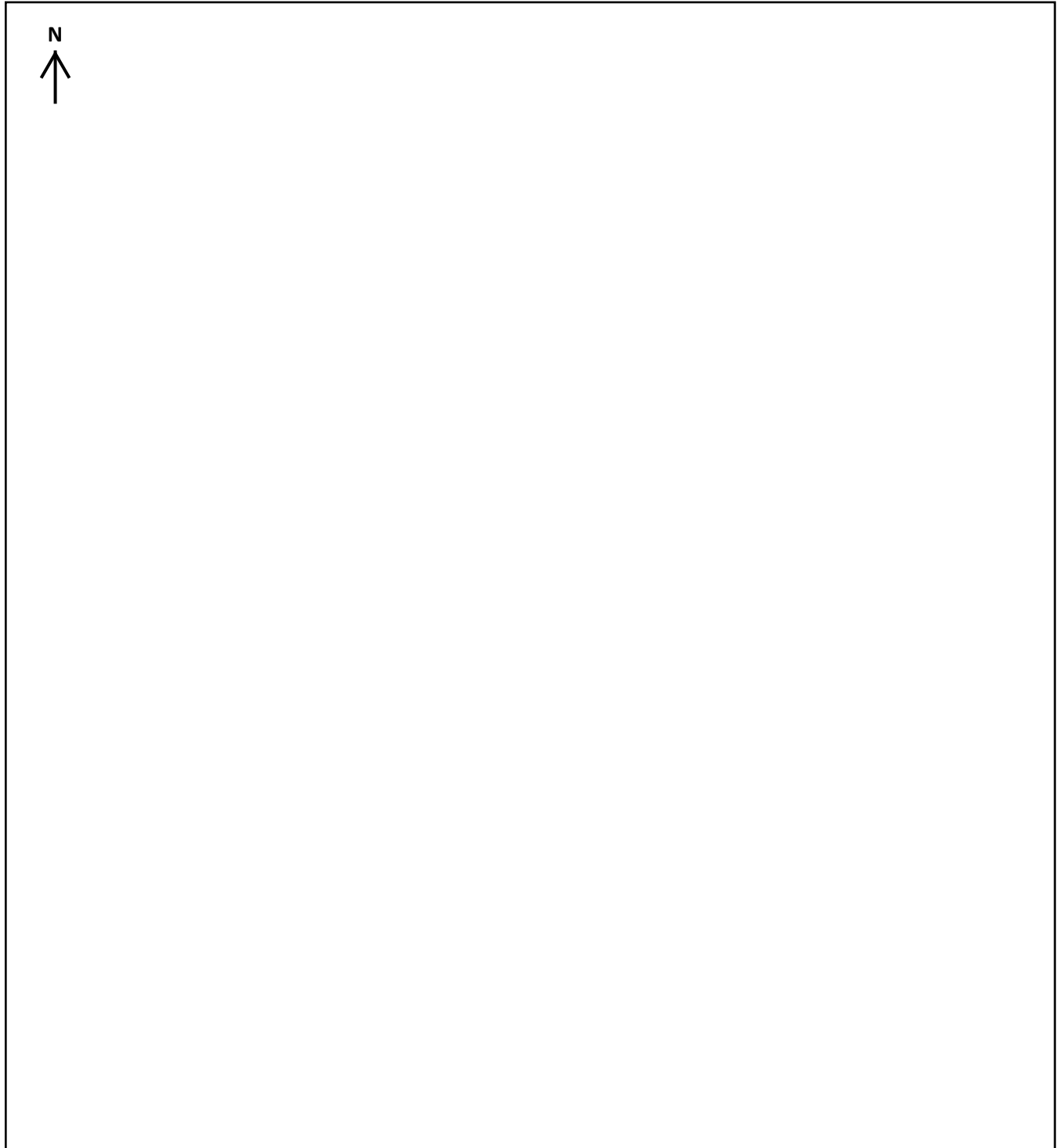
15. Other Agencies on Scene: _____

16. Response Actions Taken: _____

17. Response Actions Planned:

18. Name , organization, and Phone # of person completing this report:

19. Map of Spill Area and Affected Structures



Complete and submit this to Surface Water Management, Water Quality Specialist, within 24 hours of the incident (fax 206-801-2785).

Appendix H: Asset Management Work Plan

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Technical Memorandum

701 Pike Street, Suite 1200

Seattle, WA 98101

T: 206.624.0100

F: 206.749.2200

Prepared for: City of Shoreline

Project Title: Shoreline Surface Water Master Plan

Project No.: 149479

Deliverable D06

Subject: Asset Management Work Plan

Date: April 12, 2017

To: Uki Dele, Surface Water and Environmental Services Manager, City of Shoreline

From: Nathan Foged, Managing Engineer, Brown and Caldwell

Copy to: Margaret Ales, Senior Engineer, Brown and Caldwell

Scott Bash, President, FCS Group

Prepared by: Scott Bash

Reviewed by: Steffran Neff

Limitations:

This document was prepared solely for City of Shoreline in accordance with professional standards at the time the services were performed and in accordance with the contract between City of Shoreline and Brown and Caldwell dated July 14, 2016. This document is governed by the specific scope of work authorized by City of Shoreline; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by City of Shoreline and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

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List of Abbreviations

AM Committee	Asset Management Committee	Master Plan	Surface Water Master Plan
AMWP	Asset Management Work Plan	MON	monitoring
BC	Brown and Caldwell	NASSCO	National Association of Sewer Service Companies
CCTV	closed-circuit television	NPDES	National Pollutant Discharge Elimination System
City	City of Shoreline	O&M	operations and maintenance
CIP	capital improvement plan	ORG	organization
CMMS	computerized maintenance management system	PLN	planning
COM	communication	PM	preventive maintenance
Consultant Team	Brown and Caldwell and FCS Group	PRG	program development
DEV	development	R&R	rehabilitation and replacement
EUL	estimated useful life	REP	reporting
FCSG	FCS Group	RSI	Required Supplemental Information
FIN	financing	SOP	standard operating procedure
FIS	financial information system	SYS	systems
GASB 34	Governmental Accounting Standards Board Summary of Statement 34	UBME	Utility Business Management Evaluation
GIS	geographic information system	Utility	Surface Water Utility
IT	information technology	VIS	vision and support
KNO	knowledge		

Executive Summary

Brown and Caldwell (BC) and FCS Group (FCSG) (Consultant Team) are working with the City of Shoreline (City) to prepare an updated Surface Water Master Plan (Master Plan) for the Surface Water Utility (Utility) that will address drainage and water quality issues associated with growth, increasing regulations, and aging infrastructure. The Master Plan will guide Utility activities for the next 5 to 10 years, and will include recommendations for capital improvement projects, policies, programs, and a financial plan for long-term asset management.

The City has identified asset management as a key element of the Master Plan. The City believes that a strong Asset Management Program will improve stewardship of the surface water system infrastructure and assure customers that funds are spent responsibly and effectively. Asset management ties Utility expenditures to customer service levels, and through increased accountability, aims to ensure that all asset decisions reflect the lowest life-cycle cost needed to meet customer expectations at responsible levels of risk.

This Asset Management Work Plan (AMWP) is intended for the Utility, and is an update to the Utility's Asset Management Program. The key highlights of the AMWP are as follows:

- The Utility staff and leadership at the City's Public Works Department determined that key business processes related to life-cycle management of assets are important to the sustainability of Master Plan and Utility activities such as planning, design, construction, operations and maintenance (O&M), capital refurbishment, and replacement.
- The Utility's business processes were compared with best practices in each of several business process categories. The cost to close the high priority gap closures is estimated at \$170,000 of contractor costs, over the next five years.
- Through several working sessions, the Utility staff and Public Works Department leadership defined, area by area, the level of performance that the Utility should aim to achieve during the next several years. The high-level areas of improvement include; aligning the AMWP with the City goals, clear communication with stakeholders and staff on the AMWP, and more detailed configuration of maintenance strategies and condition assessment efforts to extend asset life and improve asset reliability
- Top management should appoint an Asset Manager with the authority to lead the Asset Management Team (AM Committee) and the resources to develop and sustain the AMWP and Program. This should include schedules and preliminary responsibilities for performance.
- The Utility can benefit from a more robust risk management plan to support operational budget and prioritize capital decision making that aligns the cost of service with level of service. This would include determining criticality for each asset based on reliability and consequence of failure in terms of cost, service delivery risk, environmental risk, etc.
- A staff education program, developed to meet skills needed and enhancing staff growth potential, will be important to support the AMWP plan and sustain the AM Program.

The process for identifying asset management needs and prioritizing actions is shown in Figure E-1.

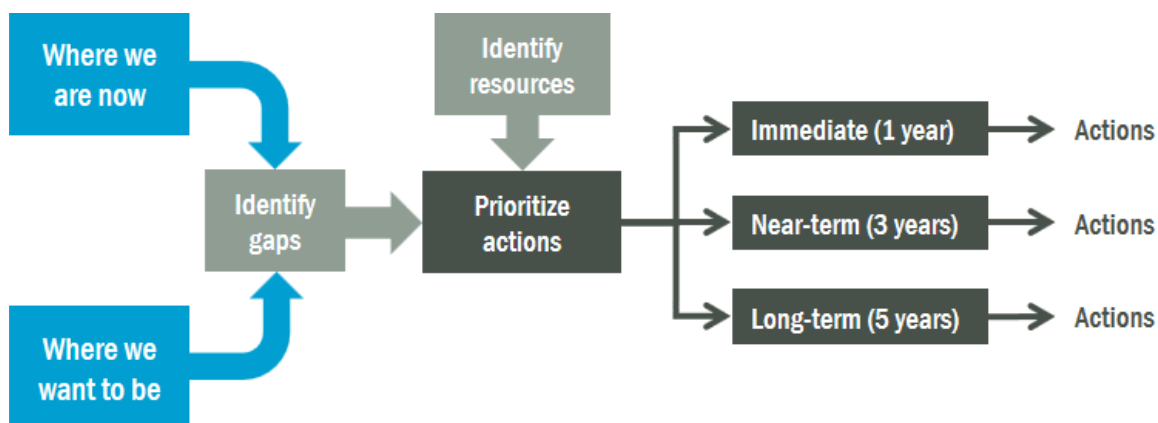


Figure E-1. Development of prioritized actions for AMWP

Table E-1 presents a summary of the estimated implementation costs for immediate, near-term, and long-term asset management needs. Detailed descriptions of the needs and actions for addressing them are provided in subsequent sections of this document. A more detailed breakdown of the cost to close the gaps is provided in Appendix A: *Gap Implementation Cost Estimates*.

Personnel	Priorities			Full implementation (total through 5 years)
	Immediate (1 year)	Near-term (3 years)	Long-term (5 years)	
Utility staff	\$49,231	\$80,090	\$62,595	\$191,916
Contractor and consultants	\$28,025	\$59,225	\$82,295	\$169,545
Total Cost	\$77,256	\$139,315	\$144,890	\$361,461

It is probable that the Utility will re-prioritize needs, define new goals, revise strategies, and change or add actions over time. These activities will necessitate continual updates to this AMWP, and thus it should be considered an actively managed living document.

Section 1: Introduction

Brown and Caldwell (BC) and FCS Group (FCSG) (Consultant Team) are working with the City of Shoreline (City) to prepare an updated Surface Water Master Plan (Master Plan) for the Surface Water Utility (Utility) that will address drainage and water quality issues associated with growth, increasing regulations, and aging infrastructure. The Master Plan will guide Utility activities for the next 5 to 10 years, and will include recommendations for capital improvement projects, policies, programs, and a financial plan for long-term asset management.

Asset management is a major element of the Master Plan. The City believes that an updated Asset Management Program will improve stewardship of the surface water system infrastructure and assure customers that funds are spent responsibly and effectively. Asset management ultimately ties Utility expenditures to customer service levels, and through increased accountability, aims to ensure that all asset decisions reflect the lowest life-cycle cost needed to meet customer expectations at responsible levels of risk. The primary goal of the Asset Management Program is to provide a structured approach to minimizing asset ownership life-cycle costs, while still meeting required service levels and providing long-term confidence in the condition of system infrastructure. The expected outcomes are lower ownership costs, assets in better condition with longer lives, and more efficient use of the Utility's staff and capital resources.

This Asset Management Work Plan (AMWP) is intended to guide the Utility through the process of updating its Asset Management Program. In preparing the AMWP, the Consultant Team worked with the Utility to complete the following activities:

- Participated in interviews to identify the Utility's strengths and weaknesses as compared to standards for asset management programs
- Analyzed and rated the Utility in 13 business process categories and 89 individual business elements
- Prepared target goals for the Utility Asset Management Program for the next 3 to 5 years
- Performed a gap analysis by comparing current practices with the target goals
- Prioritized needs and developed performance targets for the Asset Management Program
- Reviewed levels of service and related actions that are critical to long-term asset management success

The following sections present the Utility's analysis of its current asset management business processes, its view of improvements needed during the next several years, and a plan for achieving those improvements through implementation of an updated Asset Management Program.

Section 2: Evaluation of Business Practices

The Utility has already completed several fundamental efforts in support of its Asset Management Program, such as defining levels of service and implementing the Cityworks computerized maintenance management system (CMMS). In addition, the Utility has established an Asset Management Committee (AM Committee) to steer and support the asset management planning process. The AM Committee's current focus is to evaluate the strengths and weaknesses of the Utility's Asset Management Program with respect to best practices for similar utilities. To accomplish this, the AM Committee worked with the Consultant Team to evaluate current business practices, identify gaps, and prioritize actions to improve the Asset Management Program (see Figure 1, below).

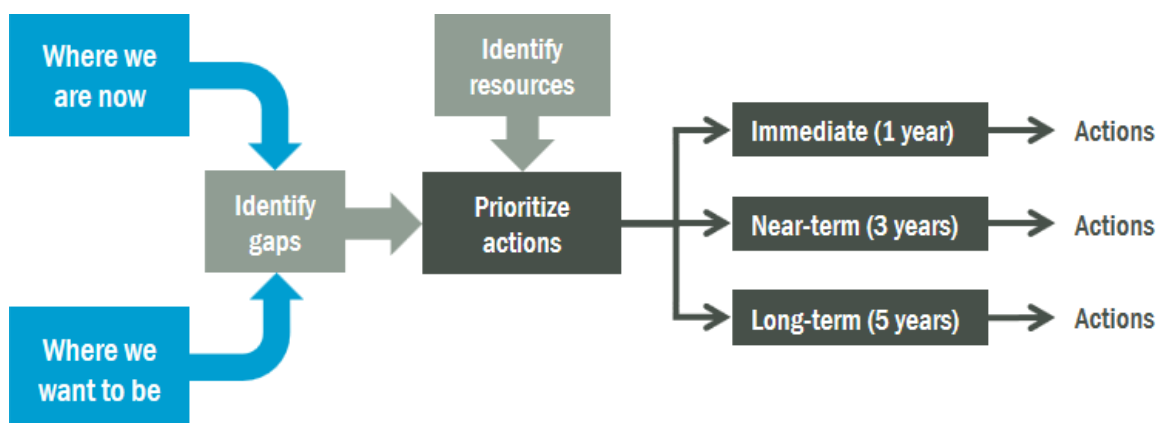


Figure 1. Process for identifying and prioritizing actions for the AMWP

2.1 Gap Analysis

The Consultant Team conducted a series of interviews with Utility staff to evaluate a wide range of business practices using its Utility Business Management Evaluation (UBME) process. The UBME groups the findings into the following major topics or business process categories:

- Management vision and support
- Organization
- Asset management program development
- Asset knowledge
- Asset planning
- Asset management program communication
- Asset development
- Asset operations and maintenance (O&M)
- Asset condition monitoring
- Asset rehabilitation and replacement (R&R)
- Asset financing
- Asset finance reporting
- Asset management systems

The Utility's current business practices were assessed and then compared with known best practices for each business element within the AM categories. The UBME (in Appendix B) provides a gap matrix showing the results of the comparison. Once current practices were evaluated, the Consultant Team worked with the AM Committee to establish a baseline score for each business element. A scoring system in the UBME was developed using five levels of maturity ranking with numeric ranges as defined in Table 1.

Table 1. Gap Scoring System

Maturity Ranking	Description	Score
Optimizing	Approach is practiced, measured, fully controlled, and has an improvement cycle focused on results	80-100
Managed	Defined documented approach, practiced, and measured—but not controlled	50-70
Defined approach	Defined approach with no controlled documentation and not practiced consistently	30-40
Initial	Aware but no systematic approach	10-20
Unaware	Total unawareness within organization	0-10

The Consultant Team held a workshop with the AM Committee to review the best practices and scores. Once the baseline scores were agreed upon, a second workshop was held to establish the target scores that correlate with desired performance levels to be reached within the next 5 years. A gap analysis was then completed by comparing current baseline scores (i.e., where the Utility is now) with target scores (i.e., where Utility staff would like to be in 5 years) based on what is achievable and consistent with the goals of the City Council (see Table 2). The difference between the target score and the current score is the numeric gap score.

Table 2. 2015–17 Shoreline City Council Goals

Goal	Description
Goal 1	Strengthen Shoreline's economic base to maintain the public services that the community expects
Goal 2	Improve Shoreline's utility, transportation, and environmental infrastructure
Goal 3	Prepare for 2 Shoreline light rail stations
Goal 4	Enhance openness and opportunities for community engagement
Goal 5	Promote and enhance the City's safe community and neighborhood programs and initiatives

2.2 Prioritization of Needs

The Consultant Team worked with the AM Committee to prioritize each business practice gap. The team used a score of “5” for those areas of the highest criticality and “1” for the lowest criticality. The gap score was multiplied by the criticality rating to calculate a weighted gap score for each business element. For example, a gap score of 30 with a criticality of 5 has a weighted gap score of 150. Weighted gap scores were sorted and used to establish priorities for gap closures as part of a final workshop. The gap closure priorities were divided into three categories as defined in Table 3. Details from the gap analysis, prioritization, and criticality scoring are included in Appendix B.

Table 3. Gap Closure Prioritization Categories and Definitions

Prioritization category	Definition
Immediate	Key activities to be completed during the next 12 months
Near term	Key activities to be completed during the next 1–2 years
Long term	Key activities to be completed during the next 5 years

The Utility prioritized each business practice and then developed overall priorities for the 13 business process category (see Table 4).

Table 4. Business Process Category Priorities for Action

Business process category	Abbreviation	Priority
Vision and support	VIS	Immediate
Organization	ORG	Immediate
Asset management program development	PRG	Immediate
Asset program communication	COM	Immediate
Asset knowledge	KNO	Near term
Asset operations and maintenance	O&M	Near term
Asset condition monitoring	MON	Near term
Asset management systems	SYS	Near term
Asset planning	PLN	Long term
Asset development	DEV	Long term
Asset rehabilitation and replacement	R&R	Long term
Asset financing	FIN	Long term
Asset financial reporting	REP	Long term

Business process category abbreviations will be used to reference specific goals and actions.

The following sections provide specific recommendations for addressing the asset management needs during the next 5 years. The goals and actions are sequenced as immediate, near-term, and long-term actions to address the priority gaps that have been identified, but also address some of the lower-based priority gaps. The Consultant Team took into consideration the City's desire to expand asset management principles city-wide, and provide a solid foundation as additional services such as wastewater are added to the program.

Section 3: Immediate Actions

The AM Committee realizes that substantial groundwork must be laid within the organization and culture to provide for a sustainable Asset Management Program. To facilitate the development of a robust Asset Management Program, the Consultant Team recommended that the following three areas be adopted first, as immediate actions, to lay that foundation during the next 12 months:

- Vision and support: Setting up and communicating the goals of asset management and communicating to all staff and stakeholders. This includes establishing goals with measurable objectives for communicating with the City Council.
- Organization: Maintaining the AM Committee as a leadership-steering team for the Asset Management Program, and allocating the resources necessary to carry the program forward. Working across the Utility to build stronger asset management principles.
- Asset Management Program development: Creating the AMWP and getting staff involved in the implementation and monitoring of success as a continually improving program.
- Asset Management Program communication: Focusing on the communication and education of staff and the work they perform will link to the services that are provided to customers and stakeholders. Identifying stakeholders and stakeholder groups, defining stakeholder interests, and developing and maintaining communication vehicles to educate stakeholders and keep them informed of progress in asset management.

3.1 Asset Management Vision and Support

An Asset Management Program is a comprehensive and deep effort cutting across many organizational boundaries. One of its aims is to increase accountability in all areas of asset stewardship. In a fundamental sense, it is a new way of doing business.

Programs of this nature require, especially at early stages, clear direction and support from top management. These programs also deserve the early understanding and support of the policy body. Accordingly, the goals, strategies, and actions in the area will aim to obtain active participation of both top management and the City Council in the development of the Asset Management Program.

The City Council holds a strategic planning and goals-setting workshop every year. The Utility plays a vital role in both the planning and execution of the Asset Management Program. It is important for the City Council to understand the objectives of asset management and for the Utility to maintain alignment of the Asset Management Program with City Council goals. Because the Utility's program will ultimately be calibrated based on its customers' required service levels, this area also includes the opening stages of definition and dialog that will lead to an understanding by both customers and the Utility itself of the relationship between the Utility's service levels delivered and the costs of service.

The following three goals have been identified as top priority gap-closure actions for maintaining vision and support of the City Council and top management, and continuing to resource the Asset Management Program.

Goal VIS-01: Obtain understanding and support from the City Council so that it understands the objectives of the Utility Asset Management Program and treats it as a policy priority that leadership can manage through measurable goals.

Discussion. City Council support is limited by its current knowledge of the Utility's Asset Management Program. The City Council has funded the implementation of the Cityworks software application to facilitate asset management, but is not aware of the additional effort that will be needed to build an Asset Management Program which includes policies and goals. Without asset management policies or goals, it is difficult to get support and funding approval from the City Council.

Actions. The following are recommended actions for achieving the stated goal:

- Develop metrics for briefing top management on an annual basis that demonstrates the effectiveness of the asset management program and benefits from improved asset management.
- Prepare a reporting template for use in a PowerPoint presentation to the City Council on the asset management program efforts. Include benefits found from other utilities and how experiences from others might impact the Utility's Asset Management Program.
- Keep top management well informed through a structured communication program (see Section 3.4, below).
- Schedule an annual City Council presentation to show progress on performance and cost of the Asset Management Program.
- Keep the City Council well informed through a structured communication program (see Section 3.4, below).
- Develop an asset management policy with near-, short-, and long-term action items for implementing the policies that are measurable. Leverage the recently developed levels of service and this gap analysis while developing the policy.

Goal VIS-02: Establish the relationship between service levels and costs.

Discussion. Opening a dialog with customers helps them to understand the issues involved, and continues customer participation in the process of defining and updating the levels of service.

Actions. The following are recommended actions for achieving the stated goal:

- Hold a meeting (or meetings) with representative customer groups (e.g., residential and commercial) to introduce the Utility's asset management initiative.
- Create a survey and customer feedback tools to solicit input as to how customers view the Utility's services and how service levels might be defined on an annual basis.
- Develop some indication of the levels of service that customers expect from the Utility, and their views of the values of various levels of service.
- Document how the Utility's overall costs are related to the service levels that are provided in all areas where service levels can be defined (e.g., environmental, satellite capacity, etc.).

Goal VIS-03: Develop a budget for funding and sustaining asset management activities.

Discussion. The Utility should use the near-, short-, and long-term actions recommended in this plan, along with the budget estimates in Appendix A and supporting policies developed by the AM Committee, to develop a funding requirement for asset management activities. Putting a price on activities will allow the Utility to analyze the Asset Management Program on par with other funding requirements, allowing it to better plan for and allocate funds. This is primarily for the software aspects of asset management and not the people or processes that are necessary to support the overall asset management program. Other than considering a new asset manager position, there are currently no specific resources allocated toward the completion of asset management tasks. Part of the purpose of this plan is identify what level of funding is needed.

Actions. The following are recommended actions for achieving the stated goal:

- Summarize near-, short-, and long-term tasks with cost estimates; where applicable, define benefits to compare benefits to costs.
- Utilize these costs to develop a budget for a city-wide Asset Management Program for fiscal year 2018.
- Review the proposed budget at a full meeting of the AM Committee (described below).
- Revise the budget proposal as necessary and submit a supplemental budget request during the 2018 budget process.

3.2 Organization

The Utility staff are taking a leading effort in developing asset management programs within the Public Works Department through the Master Plan update. The Utility's Asset Management Program should be centrally directed and coordinated by a cross-functional and formally recognized AM Committee at the City level. The AM Committee should ideally have senior representation of each department, including at least Administrative Services (Finance); Planning and Community Development; Parks, Recreation and Cultural Services; and all of Public Works. The AM Committee would:

- Continue to develop the Utility's AMWP (i.e., later versions of this document).
- Develop goals and measurable objectives for the program, to be reflected in the AMWP.
- Manage the development of business processes and associated procedures that are required to improve the Utility's asset management practices.
- Continue the work of the Utility staff in identifying and prioritizing areas for improvement.

Goal ORG-01: Formalize the Asset Management Program developed for the Utility as a City-wide program.

Discussion. Management strongly and visibly supports improved asset management, though most of the support thus far has been around Cityworks implementation. There is room for moving management direction beyond Cityworks and toward an enterprise Asset Management Program.

Actions. The following are recommended actions for achieving the stated goal:

- Revise charters for the Cityworks Steering Committee and Executive Team to reflect a broader emphasis on a city-wide Asset Management Program.
- Prepare a short proposal for top management consideration to approve the asset management charter and promulgate the project brief.
- Use the AM Committee to develop the necessary asset management policies and goals as recommended in the “Support from the Policy Body” gap closure goal VIS-01.
- Develop written goals, policies, and responsibilities for the Asset Management Program

Goal ORG-02: Until an asset management position is funded and appointed, it should be the responsibility of the committees to establish asset management priorities and recommend required resources. The committees should work with applicable managers to oversee asset management projects.

Discussion. Asset management responsibility ideally rests with an appointed asset manager, who has the authority and resources to develop and to sustain the Asset Management Program. Top management is refining the responsibilities of an asset manager position and assessing the level of staffing to fulfill those responsibilities. In the interim, the information technology (IT) division manager is acting as the Utility’s asset manager.

Actions. The following are recommended actions for achieving the stated goal:

- Prepare a job description with roles, responsibilities, and criteria for the Asset Manager position.
- Use asset management policies and objectives to determine and allocate the necessary accountability and responsibility to the asset manager position.
- Determine what responsibilities can currently be accomplished through existing management and asset management teams to best leverage existing resources.
- Appoint an asset manager.

3.3 Asset Management Program Development

The following goal was created to address gaps associated with development of the Asset Management Program.

Goal PRG-01: Create a communication plan for presenting the AMWP

Discussion. Further development of the Utility’s Asset Management Program will be the responsibility of a city-wide AM Committee. Some of the work in this area has already been completed; further work of the AM Committee in the immediate future will be aimed at completing the tasks outlined above, implementing the AMWP, and updating and improving the AMWP.

Actions. The following are recommended actions for achieving the stated goal:

- Facilitate a workshop to initiate the AMWP with Utility staff to give them an opportunity to provide feedback on the AMWP and help them understand their role in its success.
- Prepare a schedule for making regular updates to the staff and stakeholders of the Utility

3.4 Asset Management Program Communication

Subsequent to the initial solicitation of top management support for the Utility’s Asset Management Program, Utility staff recognize the need for ongoing communication with stakeholder groups—all of whom will

benefit from improved asset management. Candidate groups might include City management, Utility staff in general, the City Council, general public, neighborhood groups, environmental interest groups, and regulatory authorities. Because each group may have interests different from the others, it will be necessary to better understand what these interests are and structure communication programs accordingly.

Goal COM-01: Identify key stakeholder groups and their interests.

Discussion. As the staff identify and communicate with key stakeholder groups, they will develop an understanding of what each stakeholder group sees as the greatest potential benefits from asset management. The goal is to engage in transparent communication through public education and outreach. This also gives staff the opportunity to communicate the issues that are important to the community, and seek its involvement.

Actions. The following are recommended actions for achieving the stated goal:

- Prepare a list of candidate stakeholder groups and an initial priority ranking.
- Create a template for a communication plan
- Maintain a communication plan to inform the community on utility goals and progress
- Discuss and determine the final stakeholder list for communication programs.
- Review and compile results of prior work and compile interest lists for each stakeholder group.
- Review and discuss interest lists at AM Committee meetings, and define communication vehicles, responsibilities, and schedules.
- Create a regular agenda item for the AM Committee to monitor the expectations of key stakeholder groups.

Goal COM-02: Improve staff education with Cityworks training to align with the Asset Management Program goals.

Discussion. Training in asset management has been limited to training in the Cityworks program; there is no formal asset management training program. Most training is done on an as-needed basis to bring an employee up to speed with regard to Cityworks. There is no identification of the required skills per position. Training should be formalized and relate to developed asset management goals. Staff should be aware of not only asset management best practices, but the link between the use of best practices and asset management decisions that impact their responsibilities. Other required training and staff skill development should be identified while developing Asset Management Program goals and tasks.

Actions. The following are recommended actions for achieving the stated goal:

- Formalize Cityworks training.
- Create a prioritized list of staff training requirements as they relate to the Asset Management Program.
- Implement asset management training on a prioritized basis
- Update position descriptions to incorporate possible new knowledge and skills to support the asset management business processes.

Section 4: Near-term Actions

The following near-term actions build on the foundation of the Asset Management Program and focus on sound business practices for developing reliable asset data, sound O&M and condition monitoring procedures, and information systems to help the Utility support those practices. The business process categories in this section should be addressed in the next 1 to 2 years:

- Asset knowledge

- Asset O&M
- Asset condition monitoring
- Asset management systems

4.1 Asset Knowledge

Asset knowledge is defined as quantified asset information that is readily available for asset management purposes. Asset knowledge is critical to achieving good asset management outcomes. The knowledge of operating assets for the Utility should be captured through asset hierarchies and inventories in Cityworks and geographic information system (GIS) software. The use of a system, such as Cityworks, to capture this information allows staff and managers to understand assets from any level and asset performance across multiple systems. Assets should be classified to enable the Utility to compare the performance of assets of similar type. The asset classification process should be well defined and documented (e.g., pump stations could be an asset class, catch basins could be an asset class, pipes by materials could be an asset class, etc.). It will be important to maintain and to build on the current asset knowledge with a disciplined approach to data governance and to make effective use of GIS and Cityworks as more assets and new services are added to the organization. Improving asset knowledge will assist in life-cycle asset management and help the Utility manage long-term costs.

The greatest area for improvement in asset knowledge is in the use of asset criticality, but more asset details could be added to Cityworks when gathering condition assessment information as it relates to analysis of asset reliability and failure data.

Goal KNO-01: Define the minimum level of detail for an asset.

Discussion. It is often difficult to determine the level at which assets should be tracked. Replacement planning, for example, may require a different level of asset detail from maintenance. The normal procedure is to track assets at the lowest level of detail required by any asset management function, but to manage assets at the level of detail appropriate to the purpose. Organizing assets in a hierarchical manner (see below) allows for managing assets at varying levels of detail.

A starting point for determining the appropriate level for tracking assets is to define an asset as a physical object meeting any of the following criteria:

- Cost equal or greater than the capitalization level.
- Defined as an asset by regulations or regulators.
- Requires periodic maintenance.
- Proper functioning important to the provision of service, Utility finances, safety, health, or the environment.

Actions. The following are recommended actions for achieving the stated goal:

- Develop a capital asset policies and procedures manual that establishes policies, guidelines and procedures for the inventory, depreciation, disposal and maintenance of all property and assets owned or leased by the City of Shoreline and defines assets with criteria for dollar threshold and age (such as replacement value greater than \$5,000 and estimated useful life of more than one year).
- Based on the initial stakeholder meetings, review the requirements for asset identification to measure service level criteria.
- Prepare a standard that defines the minimum level that an asset will be identified in the fixed asset register to gain alignment with the asset hierarchy, by asset class, in Cityworks.
- Develop and maintain asset performance metrics for each class of asset.

Goal KNO-02: Establish a uniform asset numbering and naming system.

Discussion. The Utility's assets need to be classified in a hierarchical manner both to allow management at different levels and to facilitate the accumulation of costs by asset, basin, facility, infrastructure segment, and so forth. Additionally, assets need to be assigned to asset classes, so that cost and life histories of similar assets can be compared—both to improve life-cycle planning and to facilitate cost savings.

The Cityworks system allows assets to be organized hierarchically and assets are routinely assigned to asset classes for various purposes, including replacement funding analysis. The Utility staff propose that the hierarchical scheme and class assignments be consistent, documented, and inherent in Cityworks, as well as the financial system, fixed asset register, capital improvement plan (CIP) and project management systems, and any other asset management process from design onward. As an example, design engineers should be able to assign asset numbers during the design process and reflect these numbers on drawings. Construction contractors should accumulate costs and provide final billing in the same manner—by asset. This will greatly improve the ability to effectively manage new facilities and accurately report financial results.

Actions. The following are recommended actions for achieving the stated goal:

- Review the Cityworks system for asset hierarchies and develop a city-wide official asset hierarchy with standard asset classes and expected life.
- Review the Cityworks system for asset class definitions.
- Prepare standard nomenclature for the asset classes to be used in the financial system and fixed asset register.
- Establish standard basin, facility, system, and piping hierarchies.
- Develop asset class definitions (will likely be embedded in the hierarchical numbering scheme).
- Prepare standard requirements for design and construction contracts for drawings and billings to conform to the Utility's asset enumeration system.

Goal KNO-03: Identify existing assets and related attributes.

Discussion. Once the appropriate level of detail for asset identification and final hierarchical numbering systems is defined, the Utility should review and update its asset management systems to conform. The primary systems that are affected will be Cityworks, the financial information system (FIS), and GIS, although other systems may be affected as well. In parallel with this effort, the Utility will need to record appropriate asset data if not recorded already. Such asset data will fall into two classes:

- Identifying information, such as serial number, date installed, and original cost.
- Parametric information, such as size, capacity, length, diameter, etc. Required parametric information will need to be defined by asset class.

Actions. The following are recommended actions for achieving the stated goal:

- Review all asset databases for conformity with the defined level of asset detail created in Goal KNO-01, with the hierarchical numbering system and asset class assignments. Re-inventory, re-number, and add/change class assignments as required.
- Investigate and determine which assets should be physically tagged with asset numbers. Define and carry out a program to tag assets.
- Define parametric data required for each asset class. Review databases and add required parametric data where not present.

Goal KNO-04: Establish a risk policy that uses a criticality rating for each asset.

Discussion. Criticality is used to prioritize workload and analysis of the consequences of failure of assets, and is essential to a sound Asset Management Program. Criticality will determine how intensively an asset is managed and how it is managed. Establish indicators of criticality, including:

- Financial consequences of unplanned failure (both internal and community costs).
- Environmental consequences.
- Health and safety consequences.
- Other service level consequences.

Based on the criticality analysis, determine how to calibrate the level of resources that are assigned to assets and systems.

Actions. The following are recommended actions for achieving the stated goal:

- Draft a triple-bottom-line risk policy that defines risk, the level of acceptable risk, consequence, criticality, and how risk is applied to asset management decision making.
- Create a field in Cityworks to track criticality ratings for assets using a 1-5 rating where 5 is a highly critical asset and 1 is a low criticality.
- Perform a risk analysis of facilities and conveyance systems, using a “top down” approach similar to that used in a vulnerability analysis.
- Establish a standardized risk management matrix for Utility assets. The matrix would be a “look-up” table for asset criticality.

Goal KNO-05: Establish asset management strategies based on criticality and risk.

Discussion. Once assets are identified and numbered and criticalities are determined, assets can be assigned to appropriate levels of management (i.e., “regimes”). The intent is to assign the most critical assets to the more intensive management regimes, so that Utility resources can be focused where they will have the greatest effect. Intensity of management will be a continuum with key reference points being:

- Condition-based management: Some assets are so critical that unplanned failures will have serious consequences. These assets will be monitored closely and replaced or repaired upon early indication to prevent unplanned failures.
- History-based management: Some assets are less critical in that unplanned failures—while undesirable—can be experienced without serious adverse consequences. These assets will be watched less closely, but will still receive periodic maintenance as applicable. Rehabilitation and replacement (R&R) will largely be based on economic analysis—for example, replacement will be done when the cost is less than the present value of the expected maintenance costs over the current asset’s lifecycle if not replaced. Capturing reliable historical maintenance cost information by asset is key to managing assets based on cost.
- Run to failure: Assets with low criticality and no periodic maintenance requirements will simply be used until broken. Analysis may even identify assets with preventive maintenance (PM) requirements where running to failure is cheaper than performing the periodic PMs.

This concept is shown graphically in Figure 2.

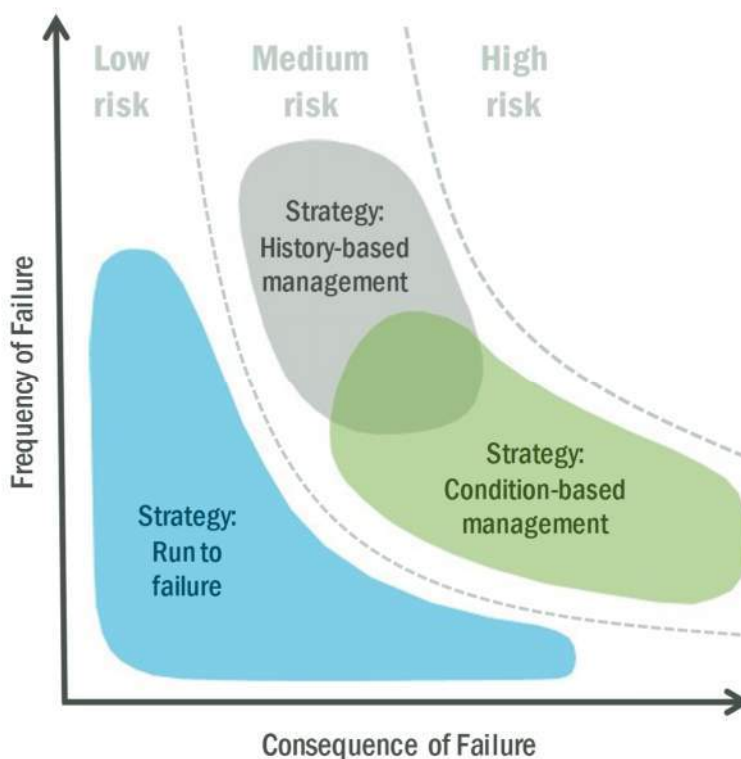


Figure 2. Asset management strategies and asset risk profiles

Assigning assets to the various management regimes in a way that matches customer service requirements helps to ensure that those requirements are met at minimal cost.

Actions. The following are recommended actions for achieving the stated goal:

- Review asset listings and assign preliminary numerical cut-off points for divisions among condition-based management, cost-based management, and run-to-failure management.
- Review results and note assets that should be assigned to different regimes (e.g., higher or lower intensity) or have special requirements (e.g., remote monitoring of condition via PM for cost reasons, even where condition-based monitoring is not indicated by criticality).
- Based on the second review, establish additional management regimes if substantial groups of assets need management methods different from the three regimes discussed above.
- Formalize the reviews by documenting the management regimes that the Utility will use and the criteria that determine to which regime an asset will be assigned.
- Establish procedures to ensure that assets are managed according to the appropriate regimes.

4.2 Asset Operation and Maintenance

The Utility identified several gap closure requirements in O&M in the areas of PM and analysis for updating the asset plans. The operations strategies employed by the Utility should be used to verify that the cost, reliability, and service levels for its assets are met. The strategies employed by the Utility should be developed using the risk profile of each basin, facility, system, asset, piece of equipment, and at every hierarchical level. The operating strategies of the assets should be developed, so the asset reliability is maintained according to the asset risk profile. These strategies should take into account the remote monitoring and

control (when available) at each of the assets and the monitoring design versus the actual set points in Cityworks.

A maintenance strategy should be maintained in accordance with the risk profile of a basin, facility, system, or asset. The maintenance options should be categorized as “run-to-failure,” “condition-based,” or “history-based” maintenance (e.g. PM that is schedule-based or runtime-based) with an analysis of the maintenance costs for all Utility assets performed annually. The cost analysis should be done by analyzing each PM task and observing the frequency and effort required. Each task should be coded by the type of labor needed to perform and complete the task. Changes to the Utility’s maintenance program should be redesigned accordingly to improve asset reliability.

The following goals were created to address these gaps and some of the lesser issues.

Goal O&M-01: Define maintenance activities at the appropriate asset level with the minimal number of work order status indicators.

Discussion. Regulatory, reactive, corrective, and PM are the main types of work orders. PM activities should always be defined at the appropriate asset level. In most cases, an inspection is what triggers a corrective work order. PM activities are defined generally by the National Pollutant Discharge Elimination System (NPDES) permit. Other PMs are ad-hoc. There are currently 18 different work order status indicators within Cityworks that can be dramatically reduced.

Because the NPDES permit drives maintenance activity, those assets that are not directly associated with the permit do not necessarily have fully defined PM activities; the Utility should define these activities starting with pump stations. For all maintenance activities, interval and resource information should be defined and tracked in Cityworks. This will enable improved life-cycle cost decision-making and more efficient maintenance planning. Stormwater asset maintenance is generally driven by the NPDES permit and the condition monitoring that comes with the permit requirements. Most maintenance work on assets is currently classified as corrective, as it is driven by required condition assessment and not a set maintenance schedule. PMs, not driven by the NPDES permit, are ad-hoc. PMs listed in Cityworks do not include interval and resource information (e.g., hours, parts lists, etc.). Additionally, there are too many work order status indicators that are used to track maintenance—this makes it more difficult to monitor progress and resource use.

Actions. The following are recommended actions for achieving the stated goal:

- Reduce the number of work order status indicators to four; preventive, corrective, emergency and regulatory.
- Add interval and resource information for all preventive maintenance work.
- Analyze adding PM activities to those assets currently not included. As an example, begin with the pump station assets and determine what activities should be done to improve the life cycle cost of the asset. Schedule those activities as PM work orders.
- Analyze moving some corrective maintenance activities to PM schedules for better resource planning.
- Develop an O&M strategy for all assets and facilities with mechanical and electrical functionality.

Goal O&M-02: Prioritize workload by risk.

Discussion. PM should be defined to mitigate the risk of asset failure. The staff need to have consistency in setting up, scheduling, and performing PM. Work orders should be prioritized based on the risk to system reliability. While such a prioritization can be done automatically if assets have criticality attributes (as recommended above), priorities will need to be manually reviewed.

Actions. The following are recommended actions for achieving the stated goal:

- Prepare procedures for defining maintenance in a proactive plan that includes a schedule and expected costs.
- Specify criticality as the starting point for prioritization with highly critical items getting the highest attention for priority.

Goal O&M-03: Track asset failures consistently.

Discussion. In asset management, most learning comes from asset deterioration and failure. Experience in these areas, if properly recorded and analyzed, helps refine maintenance programs and improves prediction of R&R timing.

Actions. The following are recommended actions for achieving the stated goal:

- Review failure codes in Cityworks and make sure that the codes support failure modes in all significant asset classes (pipes, structures, pumps, etc.). Update as required.
- Educate staff on use of failure codes and failure analysis.
- Prepare procedures to require that root-cause analyses be performed for all assets requiring reactive maintenance or removal from service and require that failure codes be used to record the event in Cityworks. There should also be a requirement to record a brief failure evaluation.

4.3 Asset Condition Monitoring

The Utility should use condition monitoring for assets where it is suitably justified to predict and to intervene before catastrophic failure. Condition monitoring techniques will be employed only where they can be suitably justified (i.e. where the cost of the technique is less than cost of the asset failure). Methods of monitoring asset condition vary according to the asset class. Once the ways in which an asset can fail are defined, monitoring methods can be chosen to predict failures. The condition rating and scoring will reflect the asset condition and allow for comparative analysis and consequence of failure analysis. Condition assessments—and trends in assessments—are normally used to support maintenance scheduling, prediction of R&R timing, and decisions on R&R actions.

The following goals were created to address gaps associated with monitoring the condition of assets.

Goal MON-01: Define condition monitoring methods.

Discussion. Asset condition monitoring was not identified as significant of a weakness as some other business processes. The Utility's review found that the *Western Washington Stormwater Manual* is used as a guide, but there was no specific or systematic approach to performing condition monitoring or determining which assets required such monitoring.

In general, condition monitoring will be used for only the most critical assets because monitoring is often expensive. Thus, the program depends on a sound criticality analysis, as discussed above.

Methods of monitoring asset condition vary according to the asset class. For example, stormwater pipes are usually monitored by closed-circuit television (CCTV) and are easier to access than some other buried assets. Rotating equipment, such as pumps and motors, may be monitored by bearing temperature, oil analysis, vibration analysis, etc. In all cases, the determination of which method to use begins with a root-cause failure analysis. Once the ways in which an asset can fail are defined, monitoring methods can be chosen to predict failures.

Actions. The following are recommended actions for achieving the stated goal:

- Perform a root-cause failure analysis on those asset classes that require monitoring,
- Create a procedure to maintain a condition rating for all assets within the Cityworks records, including those assets that are maintained by contractors.

- Change the condition assessment score to 1 through 5, following a standard similar to the National Association of Sewer Service Companies (NASSCO) or the International Infrastructure Management Manual, where 1 is ‘very good condition’ and 5 is ‘asset unserviceable’.
- Develop a condition assessment protocol for pump stations.
- Based on the failure analysis, define the different kinds of condition monitoring methods and frequencies that will be used to track asset performance and reliability.

Goal MON-02: Define the Condition Monitoring Program.

Discussion. Defining an appropriate Condition Monitoring Program is fundamental to establishing a cost-effective Asset Management Program. Condition monitoring must be used where—and only where—it makes economic sense or protects customer service levels. The assets to be monitored and the frequency of monitoring will be governed by asset criticality and the susceptibility of the asset to predictive assessment. Condition assessments and trends in assessments are normally used to support maintenance scheduling, prediction of R&R timing, and decisions on R&R actions. For condition monitoring to make its best contribution, it needs to be reliably used for these purposes.

Actions. The following are recommended actions for achieving the stated goal:

- Prepare and review an asset listing rank that is ordered by criticality.
- Prepare procedures to implement the program and use the results in normal operations where possible. Based on the results, expand the program over time to all assets qualifying for assessment.
- Prepare procedures to ensure that assessment information, along with criticality, is used to evaluate overall risks and to prioritize corrective maintenance schedules.
- Prepare procedures for using trend analyses of assessed condition, along with criticality and performance measures, to analyze and to forecast R&R needs, timing, and costs.

4.4 Asset Management Systems

The following goal is intended to address gaps associated with asset management systems.

Goal SYS-01: Prepare a system use plan for the Cityworks CMMS.

Discussion. Cityworks is fundamental to the success of the AMWP. Cityworks is used by the Public Works Department for managing assets in the Utility and Operations, Engineering, and Transportation divisions, as well as Fleet and Facilities. The Parks, Recreation, and Cultural Services Department and Ronald Wastewater district are not using Cityworks, but have plans for implementation.

Cityworks is not currently integrated to the City’s FIS, so it is not integral to forecasting long-range R&R needs and to providing funding analysis. Planning for that level of integration has not started. A new FIS is being procured and once it is implemented, further evaluation and integration should be considered. There will likely be an interface between GIS and the new FIS. If these systems are integrated, it will not be until 2019 or later.

At this point in time, there is no link between an inventory system and Cityworks. Material costs are tracked within Cityworks, but there is no inventory database. Most of the repair work is contracted and invoiced to the Utility. Material or use of material is included in the contractor cost and not itemized in contractor invoices.

Information systems are planned and budgeted annually with a 3-year forward forecast of needs that are gathered from all departments of the City. The Utility uses some mobile data-collection tools to streamline the process of data input and improve the accuracy of information in the databases—but they are not widely used. At this point, there are no tools for forecasting asset management needs. Tools like RIVA are being considered and the Utility is open to the investigation of similar tools.

Standards and protocols for data usage and asset information systems exist in the form of policy. One reason is enforceability, such as with mobile devices. Employees have access to this policy in the employee handbook, which includes standard operating procedures (SOPs) and workflow diagrams for the use of Cityworks. There was an effort to standardize the data elements in 2015 for all surface water asset information.

Actions. The following are recommended actions for achieving the stated goal:

- Develop a technology roadmap for how Cityworks is going to be maintained, used by the staff, and integrated with other systems.
- Prepare the specifications for a software product that can help the Utility perform trending analysis of assessed condition, criticality and system performance that may also be used to forecast R&R needs, timing, and costs.
- Maintain a configuration management document to track the configuration and system requirements.
- Use Cityworks to track labor, materials, and equipment cost on all work orders.
- Investigate linking Cityworks to the fleet management software system used by Mountlake Terrace.
- Design an inventory management system using Cityworks Storeroom module to track materials by work order or a system that interfaces with Cityworks to track materials by work order.
- Maintain the Cityworks user group and a user log with best practices, common issues, problems, and solutions.

Section 5: Long-term Actions

The following long-term actions focus on improving the Asset Management Program and will take several years to develop. Work on all of these recommendations can begin now, but, in most cases, the Utility will not see the results until the immediate and near-term actions have been initiated.

The long-term business process categories include:

- Asset planning
- Asset R&R
- Asset development
- Asset financing
- Asset financial reporting

5.1 Asset Planning

Asset planning refers to the preparation of the expected life-cycle costs of ownership of an asset. Such costs typically include costs of short-interval activities, such as maintenance, condition assessment, cleaning, calibration, and so forth. These costs are usually reflected in O&M or operating budgets and the plans themselves are reflected in the maintenance job plans in Cityworks. Ownership costs also include the larger expenditures for acquisition, refurbishment, or major repairs and replacement of assets are usually reflected in capital budgets. Asset planning is important for two reasons:

- A key goal of asset management is reducing asset ownership costs. This is accomplished through the classical plan/act/measure/control cycle. Asset management works by preparing plans for assets, carrying out the plans, measuring the results, and updating the plans accordingly.
- Having cost-of-ownership plans for all assets means that the Utility can accurately forecast aggregate ownership costs well into the future, giving a solid foundation for long-range funding plans.

The second item implies that the asset listing must be comprehensive and include all infrastructure assets of value. Asset types may go well beyond those typically found in maintenance management systems, which are primarily concerned with mechanical, rotating, and electrical equipment. Asset management must also consider assets, such as process structures, buildings and roofs, roadways, parking lots, etc. The assets reflected in the City's FIS should align with the same classifications of asset in Cityworks for comparison and annual assessment of total asset valuation.

Asset planning normally starts with generic asset plans developed by asset class. These are then applied to relevant assets and used for planning purposes until better plan information is developed through condition assessment, cost tracking, and so forth.

Asset plans give the Utility a snapshot of important information concerning an asset. The asset plans for the assets owned and operated by Utility should be kept in an electronic database system. The Utility would use asset plans in the building of systems and facilities, such as those produced by business case evaluations (BCE), to provide the basis for more detailed operation and maintenance strategies and R&R plans. Once the systems or facilities are in operation, it will measure and periodically compare actual ownership costs with forecasted costs to improve future forecasts. The Utility can then measure its actual ownership costs for existing systems and facilities and prepare similar asset plans for these new system or facilities. An asset plan is a roadmap to asset ownership costs, expressing best estimates of these costs throughout the entire asset lifecycle. In addition, the asset plan includes operations and maintenance strategies for the asset as well as rehabilitation and refurbishment plans.

Goal PLN-01: Develop clear reporting mechanisms that track program goals so staff can see how asset management impacts them.

Discussion. Asset management understanding exists primarily with Utility staff. If the Asset Management Program were to focus on only the Utility, this would not be adequate because all segments of the City—from Finance to Customer Service—are impacted by asset management policies. Outside the Utility, City staff are generally not aware of how asset management will impact them. The framework for effective communication of asset management throughout the City exists. Tools like SharePoint and the AM Committees can be leveraged to successfully communicate the Asset Management Program.

Actions. The following are recommended actions for achieving the stated goal:

- Leverage the AM Committee to introduce the program to other staff and to ensure that committee membership is representative of staff impacted by asset management.
- Develop report templates that staff can use to track the program.
- Load planned projects into a project layer of GIS, so that future or potential assets can be seen by field staff, planning and engineering.

Goal PLN-02: Establish short-interval portions of asset plans.

Discussion. Aspects of the short-interval portions of asset plans (primarily PM) are not fully defined in Cityworks. These asset plans should be developed to ensure that they are asset-specific, so cost data can be gathered in accordance with the asset hierarchy defined above. Where necessary, additional activities (primarily condition monitoring) can be added and maintained in Cityworks.

Actions. The following are recommended actions for achieving the stated goal:

- Review Cityworks weekly to ensure that all PM activities are represented at the appropriate level and with standard costs.

- Review capability for extracting both plan and historical cost data from the Cityworks database for further analysis. This will be required because Cityworks has only a limited analytical capability for determining asset reliability and asset deterioration.

Goal PLN-03: Establish the long-interval portions of Utility asset plans.

Discussion. Cityworks is not used to maintain plans for long-interval activities, such as R&R, nor does it gather and report costs for these activities. Pending further system review, it is unclear at this time whether these activities can be maintained in Cityworks or whether they should be stored in a separate database and combined with short-interval information via extraction from Cityworks. An example of a long interval activity would be the capital work needed to upgrade or maintain asset reliability over the asset life cycle. For pump stations this might be the scheduling of capital outflow every 8 years to upgrade pumps, maintaining this as a placeholder on a capital plan. For pipes this would be a line item for repairs and improvements that is reevaluated on an annual basis.

Actions. The following are recommended actions for achieving the stated goal:

- Review the used of the Cityworks Contracts module to manage projects associated with long-interval activities that improve asset performance.
- Prepare generic long-interval plans using an asset class-based approach. Enter into the Cityworks (or alternative) database by asset.
- Modify the generic plans where specific timing and/or costs of long-interval activities are known (e.g., planned asset replacements).

Goal PLN-04: Develop procedures to update asset plans by asset class.

Discussion. Asset plans need to be established and updated regularly based on changes in the asset performance and on improved knowledge of costs of ownership, either at the class level or the individual asset level. Improved knowledge will become available through regular reviews of asset condition, criticality, performance, and ownership costs versus plans.

Actions. The following are recommended actions for achieving the stated goal:

- Conduct a review of the current procedures for planning future capital cost on existing asset and methods for tracking cost and performance.
- Prepare procedures to analyze asset histories versus plans, so plans can be updated to reflect the best current knowledge on maintenance frequencies and activities, as well as expected R&R needs.

5.2 Asset Rehabilitation and Replacement

One of the focuses of asset management is the improvement of asset R&R decisions. The focus of R&R goals will vary; in the case of highly critical assets, the goal would be full risk avoidance. In the case of less critical assets, the goal would be to better manage risk. Improved asset knowledge is the key to better R&R decisions—criticality, condition, cost, and performance need to be considered in the analysis.

Improved R&R decisions may go well beyond questions of timing. Where any major re-investment in an asset is required, the entire process for asset creation (e.g., needs analysis, alternatives formulation, etc.) should be revisited. Improved R&R planning arising from asset knowledge greatly improves the quality of capital funding strategies.

Goal R&R-01: Begin using and analyzing failure codes to refine maintenance activities as well as R&R schedules.

Discussion. The maintenance strategy should move past NPDES-driven schedules toward needs based on failure analysis. When an asset fails, information gathered about that failure is useful for determining

maintenance and replacement activities for similar assets. Currently, stormwater asset failures are not analyzed using any type of formal process and failure codes are generally not used.

One reason for this is the NPDES permit, not failure analysis, drives maintenance activities. However, the Utility has taken some steps to adjust maintenance schedules for problem assets; certain problem areas (32 known “hot spots” with drainage issues) are identified and PM activities are altered as necessary for these.

Actions. The following are recommended actions for achieving the stated goal:

- Train staff on the use of failure codes and monitor their use for O&M activities.
- Develop SOPs for updating O&M activities based on failure codes.
- Link R&R schedules to failure codes analysis.
- For all of these tasks, start with a few priority asset classes and work through the system until all appropriate assets are covered.

Goal R&R-02: Improve R&R planning.

Discussion. The Utility should link its annual R&R budget more closely with actual asset needs. Some of this need should come through estimated useful life (EUL) and replacement costs as the information becomes available. The Utility does not have to determine this information all at once, but can instead prioritize R&R analysis on critical assets in the short term.

The maintenance of asset plans (see the above section) fulfills this goal. To the extent that the long-range portions of the Utility’s asset plans reflect good asset knowledge, R&R plans for individual assets and for assets in aggregate will be dependable. This will support the maintenance of adequate reserves or other funding mechanisms for upcoming R&R costs.

The Utility retains a set R&R budget for pipes, which is updated annually and based on the prior budget. While this is a positive step in R&R planning, this line item is not linked to asset needs. Data exist to estimate the remaining useful life of assets and improve R&R planning. However, this information is not calculated.

Cityworks is one tool that can help identify asset replacement costs. Currently, there is no consistency in identifying the replacement cost of an asset in Cityworks.

Actions. The following are recommended actions for achieving the stated goal:

- Develop a process for developing and updated the replacement costs for assets, generally included in R&R and other programmatic funding.
- Use condition data and any available estimates of EUL to provide an initial assessment of R&R needs for priority assets and build a system to track these estimates.
- Create a process for how to compare future asset needs to current funding available, and build a business case evaluation approach for appropriate funding levels.

Goal R&R-03: Improve R&R analysis.

Discussion. Proper R&R analysis requires a continual improvement type of process to evaluate performance and ensure that sub-optimal decisions made in the past are not repeated. Asset replacements should be done within well-defined strategies for different asset classes and within different operating risks. Replacements take into account obsolescence and efficiency and be complementary to long range planning efforts. The strategies for routine asset replacements should be translated into decision support models that ensure that decisions are consistent and made in a timely manner. The analysis approach is to identify assets for R&R and look broadly at the performance of the electrical/mechanical/structural asset base and rank assets and equipment according to selected parameters such as rate of failure or reactive maintenance

costs. This ranking will generate a prioritized list of assets, which will be subjected to further economic evaluation

Actions. The following are recommended actions for achieving the stated goal:

- Prepare procedures for “first-cause” needs analyses to be performed and documented prior to approving major R&R decisions.
- Prepare procedures for benefit-cost analyses of all reasonable alternatives for meeting the identified needs.
- Establish a process to track capital budgets on a monthly basis that includes R&R expenditures, estimates of capital expenditures, and adjustments.

Goal R&R-04: Ensure that R&R actions are properly reflected for financial reporting.

Discussion. Rehabilitation (and sometimes replacement) actions are often improperly recorded in the fixed asset register used to report asset value and depreciation. The fixed asset register should have a structure that tracks specific asset retirement units such as; concrete pipes, steel pipes, concrete structures, pumping equipment, The Utility’s current fixed asset register shows the depreciation of assets as grouped within projects over time and does not always show the depreciation of a specific asset or group of assets by asset class. Common problems with this lack of detail include failure to retire assets that leave service and failure to extend the life of the underlying asset. The effect of errors may be cumulative over time and lead to material misstatements of the financial condition.

The costing of R&R actions should include all appropriate direct and indirect costs of the Utility, as required by Governmental Accounting Standards Board Summary of Statement 34 (GASB 34). The Utility did not specify any required gap closure in the area; however, the AM Committee may determine that some additional action is required in this area in the long term.

Actions. The following are recommended actions for achieving the stated goal:

- Prepare guidelines for classifying R&R transactions for financial reporting purposes.
- Prepare procedures for analyzing and reporting R&R transactions as retirements, replacements, and improvements. In the case of the latter, the procedure should involve increasing the cost basis of the asset rather than adding a new asset.
- For refurbishments that affect the useful life of the underlying asset, procedures should ensure that the fixed asset register is updated to reflect the new remaining useful life that is in Cityworks.
- Prepare procedures for costing R&R actions that ensure appropriate internal Utility costs are included in R&R costs transferred to the fixed asset register. A standard percentage is often used for this purpose.

5.3 Asset Development

The role of asset management in asset creation is to ensure that the Utility optimizes its investment in new infrastructure. That means that the Utility always makes investments that are appropriate, the best alternatives to meeting the identified needs, contribute to meeting required service levels, and have the lowest life-cycle costs for the customer.

Asset creation is a critical role for asset management because the initial choice of an asset is where the greatest opportunity for savings exists.

Goal DEV-01: Formalize the life-cycle costing approach for capital improvement projects to better capture O&M costs over the lifetime of the asset.

Discussion. The Utility can begin tracking the life-cycle costs of new and future assets to better reconcile forecasted and actual costs. The cost to maintain assets can and should be tracked through Cityworks.

There is some effort already under way to capture life-cycle costs for stormwater assets. One effort is in capital improvement planning. Alternative analysis for stormwater assets is done through basin plans; however, life-cycle costs of alternatives are not prepared according to defined formats. Although the Utility is beginning to track O&M costs in overall CIP budgeting and forecasts, reconciliation of these forecasts do not happen after the project is complete.

Life-cycle costs for assets are not well tracked. Although there is a goal to link financial reporting directly with assets, this does not currently occur. It is more common for projects (or the total cost of the contract amount) to be depreciated in the fixed-asset register instead of assets as a retirement unit.

Actions. The following are recommended actions for achieving the stated goal:

- Establish a procedure for conducting an alternative analysis on major (greater than \$100,000) projects that looks at the life cycle costs, including the risk and benefits costs, as part of the capital planning procedures.
- Prepare guidelines on how to develop simple life-cycle cost options for major capital improvement projects.
- Conduct an analysis of the life-cycle costing approach for general R&R programs for stormwater to better assess maintenance and capital options for these assets.
- Improve links between financial accounting of fixed assets and assets in Cityworks, so that an asset that can located in the field can be identified in the fixed asset register.

Goal DEV-02: Develop a systematic approach to creating new assets.

Discussion. Utilities adhering to programmatic asset management have developed procedures to ensure that capital investment is minimized and consistent with required service levels. Typically, life-cycle benefit/cost analyses are required for all new projects. While these analyses may not be able to quantify certain benefits, such as regulatory or safety benefits, they can highlight the costs of such benefits and thus facilitate a far more rational approach to capital investment.

Actions. The following are recommended actions for achieving the stated goal:

- Develop an asset onboarding process.
- Prepare procedures for initiating projects and determining the need for new assets or systems. These procedures will govern needs analysis (i.e., problem definition), alternatives formulation and analysis, benefit-cost analysis, and ultimate selection of the preferred alternative.
- Define the life-cycle costing in such a way that life-cycle cost of the preferred alternative becomes the initial asset plan for that alternative.
- Require that consultants, if performing such analyses, follow Utility standards.

Goal DEV-03: Require that enumeration schemes be followed by designers and contractors.

Discussion. The Utility will develop a hierarchical asset enumeration scheme to be shared by all asset-based systems and allow cost analysis by process, facility, infrastructure segment, etc. To save money and time, the Utility's consultants and contractors should use this enumeration scheme through the design and construction cycle.

Actions. The following are recommended actions for achieving the stated goal:

- Add asset enumeration requirements to the standard language for design contracts. Require that all drawings be delivered with assets numbered accordingly.
- Add similar requirements to construction contracts. Require that final pay notices be rendered in detail according to the enumeration scheme. This will ensure that the original cost of each asset is known and can be recorded in the fixed asset reporting system.

Goal DEV-04: Maximize contractor contribution to asset plan development.

Discussion. For new or rehabilitated assets and facilities, contractors can substitute for Utility or consultant labor by providing asset planning and related information. It will be worth the effort to prepare standardized electronic forms for capturing these data, so they can be easily transferred to the Utility's asset-based systems.

Actions. The following are recommended actions for achieving the stated goal:

- Prepare procedures and forms for contractors to submit. All data elements should be organized by asset, numbered per the Utility's asset hierarchy. The data elements required might include:
 - Maintenance information (e.g., activity, frequency, parts and materials) for each PM type.
 - EUL of the asset—note that a legal release might be required to protect the contractor against premature, but out-of-warranty, failure.
 - Cost of the asset.
 - Nameplate information.
 - Attribute information (see discussion regarding asset classes, above).
 - Warranty information.
- Add language to construction contract boilerplate to require contractors provide the information in the defined form.
- Additionally, require that contractors deliver all O&M manuals and similar documentation in hard copy.

5.4 Asset Financing

The Utility's asset financing strategy should include life-cycle planning, decision making, and all necessary financial management components to meet the City's financial reporting requirements. Better knowledge of future capital needs and O&M costs will improve the quality and dependability of the Utility's strategic plan and better document the Utility's future funding needs. It is important for the Utility to understand its costs well enough to make defensible estimates of future costs so proper budgets can be prepared and resources can be properly allocated. Improved cost forecasting allows for improved management of assets through the decision making process. Better forecasting of asset replacement costs over several years will help the Utility to better identify future funding needs and have better control of rates. Policies that balance R&R against new projects and improvements will result in more control of rate fluctuations.

The Utility did not identify any significant gaps in this area, but there is the opportunity for more consistency between Cityworks and the financial system records. The items below are some additional goals for consideration to improve overall Asset Management Program performance.

Goal FIN-01: Improve the use of trending for long-range capital funding plans.

Discussion. Capital funding plans are based on future capital needs, which are made up of two main categories of expenditures: (1) new assets/improvements, and (2) capital reinvestment (or R&R). The Utility determined that knowledge of long-range R&R needs could be improved with better cost trending and better knowledge in this area will improve the quality and dependability of the Utility's funding plans.

Actions. The following are recommended actions for achieving the stated goal:

- Develop systems or software to forecast R&R needs over a longer time frame than is currently the case, typically during the entire economic useful life.
- Incorporate projected R&R needs along with known near-term needs into the Utility's capital funding plans.
- Set up a CIP priority process to select, track, and monitor all capital projects.

- Maintain the long-range plans by re-forecasting R&R needs as asset knowledge improves and update the plans to make the most effective use of available capital.

5.5 Asset Financial Reporting

Financial reporting, especially fixed asset reporting, is an important element of asset management. Given that the Utility intends to comply with the depreciation approach of GASB 34, it is important that representations of asset value and depreciation be accurate and based on best asset knowledge—knowledge that is shared with other functions within the organization. The only significant gap in this area is around consistency in reporting addressed in Goal REP-01. The additional items below are goals for consideration to improve overall asset management performance.

Goal REP-01: Improve consistency of the FIS asset database.

Discussion. The Utility has not taken steps to coordinate its financial reporting database with Cityworks asset records. There should be an annual update procedure to keep the two in synchronization—there are many inconsistencies.

Actions. The following are recommended actions for achieving the stated goal:

- Review the fixed asset list, Cityworks CMMS, GIS system, and financial system (IFAS) databases. Prepare more comprehensive procedures to ensure that they reflect the same asset knowledge at the same level of detail to the asset retirement unit (pipe, instrumentation, structures, electrical etc.).
- Develop reports that assist with production and performance analysis, which include actual versus budgeted/planned work.
- Review fixed asset records and re-define them according to the asset hierarchy; review of GIS records may help with this.
- Allocate acquisition costs of grouped assets as required for specific assets and define useful lives of classes, so depreciation can be calculated based on the new structure.

Goal REP-02: Improve procedures to keep the fixed-asset records up to date.

Discussion. For accurate financial reporting, the fixed asset records must be kept current. This means accurately reflecting all additions, retirements, partial retirements, augmentations, and improvements in the Utility's capital assets in the records. It also means that the fixed asset records must reflect current, best forward-looking asset knowledge.

Actions. The following are recommended actions for achieving the stated goal:

- Review procedures for inter-department communications and creating asset transactions, particularly for retirements, refurbishments, and augmentations. Ensure such activities are known and used to update the fixed asset records and, in the case of augmentations or refurbishments, useful lives as necessary.
- Prepare procedures to ensure that as asset knowledge improves around areas, such as expected replacement years by asset class or for specific assets, fixed asset records are updated accordingly in IFAS.

Section 6: Implementation Costs

The implementation costs in Table 5 below are estimates of the internal Utility costs and potential external costs from contractors and consultants contracted to assist the Utility with developing the Asset Management Program. A more detailed breakdown of the cost to close the gaps is provided in Appendix A: *Gap Implementation Cost Estimates*. The hours are estimates of hours to complete the work for each of the gap areas. A loaded hourly labor rate of \$75 was used for the Utility labor cost and \$130 per hour was used for the contracted work. The total implementation cost during the next 5 years for all gap closures is expected to be roughly \$361,500 (in 2017 dollars).

Table 5. Implementation Cost Summary				
Personnel	Priorities			Full implementation (total through 5 years)
	Immediate (1 year)	Near-term (3 years)	Long-term (5 years)	
Utility staff	\$49,231	\$80,090	\$62,595	\$191,916
Contractor and consultants	\$28,025	\$59,225	\$82,295	\$169,545
Total Cost	\$77,256	\$139,315	\$144,890	\$361,461

It is probable that the Utility will re-prioritize needs, define new goals, revise strategies, and change or add actions over time. These activities will necessitate continual updates to this AMWP, and thus it should be considered an actively managed living document.

Attachment A: Gap Implementation Cost Estimates

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	AMWP Gap Implementation Costs			Shoreline Staff				Contractor / Consultant Staff			
				Staff Loaded Rate		\$75		Cont. Loaded Rate		\$130	
	Business Process Area	Goal	Total Cost	Staff hours	Staff labor costs	Staff ODCs	Internal total cost	Contractor hours	Contractor labor	Contractor ODCs	Contractor Total
Immediate Actions	Asset Management Vision and Support	VIS-01 Obtain understanding and support from Shoreline's City Council	\$5,625	75	\$5,625	\$0	\$5,625	0	\$0	\$0	\$0
		VIS-02 Establish the relationships between service levels and costs.	\$11,875	85	\$6,375	\$0	\$6,375	40	\$5,200	\$300	\$5,500
		VIS-03 Develop a budget for funding and sustaining asset management activities.	\$4,125	55	\$4,125	\$0	\$4,125	0	\$0	\$0	\$0
	Asset Management Organization	ORG-01 Formalize the Asset Management Program developed for the Surface Water Utility as a City-Wide program.	\$14,800	65	\$4,875	\$25	\$4,900	70	\$9,100	\$800	\$9,900
		ORG-02 Establish asset management priorities and recommend required resources	\$13,526	90	\$6,750	\$26	\$6,776	50	\$6,500	\$250	\$6,750
	AM Program Development	PRG-01 Create a communication plan for presenting the AMWP	\$5,245	55	\$4,125	\$55	\$4,180	8	\$1,040	\$25	\$1,065
	AM Program Communication	COM-01 Identify key stakeholder groups and identify their interests.	\$4,250	50	\$3,750	\$500	\$4,250	0	\$0	\$0	\$0
		COM-02 Improve staff education with Cityworks training to align with the AM Program Goals.	\$17,810	60	\$4,500	\$8,500	\$13,000	32	\$4,160	\$650	\$4,810
	Total for Immediate Actions		\$77,256	\$49,231				\$28,025			
Near-Term Actions	AMWP Gap Implementation Costs			Shoreline Staff				Contractor / Consultant Staff			
				Staff Loaded Rate		\$75		Cont. Loaded Rate		\$ 130.00	
	Business Process Area	Goal	Total Cost	Staff hours	Staff labor costs	Staff ODCs	Internal total cost	Contractor hours	Contractor labor	Contractor ODCs	Contractor Total
	Asset Knowledge	KNO-01 Define the minimum level of detail for an asset.	\$17,380	160	\$12,000	\$450	\$12,450	36	\$4,680	\$250	\$4,930
		KNO-02 Establish a uniform asset numbering and naming system.	\$9,525	75	\$5,625	\$300	\$5,925	26	\$3,380	\$220	\$3,600
		KNO-03 Identify existing assets and related attributes.	\$11,910	90	\$6,750	\$180	\$6,930	36	\$4,680	\$300	\$4,980
		KNO-04 Establish a risk policy that uses a criticality ratings for each asset	\$10,750	75	\$5,625	\$225	\$5,850	36	\$4,680	\$220	\$4,900
		KNO-05 Establish asset management strategies based on criticality and risk	\$11,220	70	\$5,250	\$260	\$5,510	42	\$5,460	\$250	\$5,710
	Asset Operation and Maintenance	O&M-01 Define maintenance activities at the appropriate asset level with the minimal number of works order status indicators.	\$11,040	85	\$6,375	\$100	\$6,475	35	\$4,550	\$15	\$4,565
		O&M-02 Prioritize workload by risk	\$9,060	55	\$4,125	\$200	\$4,325	36	\$4,680	\$55	\$4,735
		O&M-03: Track asset failures consistently	\$11,335	90	\$6,750	\$200	\$6,950	32	\$4,160	\$225	\$4,385
	Asset Condition Monitoring	MON-01 Define condition monitoring methods.	\$11,465	85	\$6,375	\$25	\$6,400	36	\$4,680	\$385	\$5,065
		MON-02 Define condition monitoring program	\$21,695	170	\$12,750	\$50	\$12,800	68	\$8,840	\$55	\$8,895
	Asset Management Systems	SYS-01 Prepare a system use plan for the Cityworks CMMS	\$13,880	85	\$6,375	\$100	\$6,475	55	\$7,150	\$255	\$7,405
	Total for Near-Term Actions		\$139,260	\$80,090				\$59,170			

	AMWP Gap Implementation Costs			Shoreline Staff				Contractor / Consultant Staff			
				Staff Loaded Rate		\$75		Cont. Loaded Rate		\$130	
	Business Process Area	Goal	Total Cost	Staff hours	Staff labor costs	Staff ODCs	Internal total cost	Contractor hours	Contractor labor	Contractor ODCs	Contractor Total
Long-Term Actions	Asset Planning	PLN-01 Develop clear reporting mechanisms that track program goals so staff can see how Asset Management impacts them.	\$10,250	35	\$2,625	\$225	\$2,850	50	\$6,500	\$900	\$7,400
		PLN-02 Establish short-interval portions of asset plans	\$10,975	40	\$3,000	\$325	\$3,325	55	\$7,150	\$500	\$7,650
		PLN-03 Establish the long-interval portions of Utility asset plans	\$11,310	42	\$3,150	\$100	\$3,250	60	\$7,800	\$260	\$8,060
		PLN-04 Develop procedures to update asset plans by asset class	\$12,275	65	\$4,875	\$100	\$4,975	55	\$7,150	\$150	\$7,300
	Asset Rehabilitation and Replacement (R&R)	R&R-01 Begin using, and analyzing, failure codes to refine maintenance activities as well as R&R schedules.	\$15,250	80	\$6,000	\$100	\$6,100	65	\$8,450	\$700	\$9,150
		R&R-02 Improve R&R planning	\$7,315	40	\$3,000	\$55	\$3,055	32	\$4,160	\$100	\$4,260
		R&R-03 Improve R&R analysis	\$15,540	120	\$9,000	\$200	\$9,200	48	\$6,240	\$100	\$6,340
		R&R-04 Ensure R&R actions are properly reflected for financial reporting	\$11,180	75	\$5,625	\$255	\$5,880	40	\$5,200	\$100	\$5,300
	Asset Development	DEV-01 Formalize the life-cycle costing approach for capital improvement projects to better capture O&M costs over the lifetime of the asset.	\$10,230	70	\$5,250	\$100	\$5,350	36	\$4,680	\$200	\$4,880
		DEV-02 Develop a systematic approach to creating new assets	\$8,355	40	\$3,000	\$55	\$3,055	40	\$5,200	\$100	\$5,300
		DEV-03 Require enumeration schemes be followed by designers and contractors	\$8,295	65	\$4,875	\$200	\$5,075	24	\$3,120	\$100	\$3,220
		DEV-04 Maximize contractor contribution to asset plan development	\$8,035	40	\$3,000	\$255	\$3,255	36	\$4,680	\$100	\$4,780
	Asset Financing	FIN-01 Improve use of trending for long-range capital funding plans.	\$4,415	36	\$2,700	\$100	\$2,800	12	\$1,560	\$55	\$1,615
	Asset Financial Reporting	REP-01 Improve consistency of the finance system asset database.	\$4,790	26	\$1,950	\$125	\$2,075	20	\$2,600	\$115	\$2,715
		REP-02 Improve change management procedures in the fixed asset records.	\$6,675	30	\$2,250	\$100	\$2,350	32	\$4,160	\$165	\$4,325
	Total for Long Term Actions		\$144,890	\$62,595				\$82,295			
	Grand Totals		\$361,406	\$191,916				\$169,490			

Attachment B: UMBE Matrix

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Attribute	Score	Vision and Support						Organization					Program Development					Asset Knowledge					Asset Planning					AM Program Communication						Asset Development													
		Support From Policy Body	Management Direction	Organizational Commitment	Customer's Perspective	Corporate AM Goals And Objectives	Allocation Of Resources	Asset Manager Responsibility	Establishment of AM Team	Asset Management Overview	Program Development	Resources and Progress	Assessment of Current Practices	Development of Vision	Analysis of Gaps	Preparation of AMWP	Communication of AMWP	AM Program Audit	Asset Detail	Asset Criticality	Asset Categorization	Asset Classes	Asset Hierarchy	Asset Identification	Asset Plans	Short-interval Activities	Long-interval Activities	Asset Plan Maintenance	Project Prioritization	Stakeholder Confidence	Service Demands	Environmental Compliance Strategy	Communication Plan	AM Strategy Awareness	Continuous Improvement Indicators	Staff Education	Origination	Scope for Projects	Alternatives	Life-Cycle Costs	Delivery Methods	Operability and Maintainability	Design Requirements	Construction Requirements	Asset Reliability and Assessment Updates	O&M Manuals, Procedures, Guarantees	Asset Tracking
Optimizing	100																																														
	90																																														
	80																																														
Managed	70																																														
	60																																														
	50																																														
Defined Approach	40																																														
	30																																														
Initial	20																																														
Unaware	10																																														
Target Practice Score (1)		50	60	60	50	50	60	60	60	60	60	40	50	40	50	50	60	40	50	50	40	40	50	50	50	60	60	50	50	50	40	60	50	50	50	50	30	50	50	50	50	50	50	50	50	50	
Current Score (2)		20	30	40	30	30	20	20	40	30	30	20	20	30	30	20	10	40	20	30	30	50	50	20	30	30	20	30	30	30	60	30	40	30	20	40	50	40	20	30	30	40	40	20	30	40	
Gap		30	30	20	20	20	40	40	20	30	30	20	30	10	20	30	40	30	10	30	10	10	0	0	30	30	30	30	20	20	10	0	20	10	20	30	10	0	10	30	0	20	10	10	30	20	10
Criticality (3)		5	5	5	4	4	5	5	4	4	5	4	4	3	4	4	5	3	5	5	5	5	5	5	4	4	4	4	4	4	3	5	5	3	3	5	4	5	5	5	1	4	4	4	4	4	4
Weighted Gap (Criticality x Gap)		150	150	100	80	80	200	200	80	120	150	80	120	30	80	120	200	90	50	150	50	50	0	0	120	120	120	120	80	80	30	0	100	30	60	150	40	0	50	150	0	80	40	40	120	80	40
Priority Ranking		1	1	2	3	3	1	1	3	2	1	3	2	3	3	2	1	3	3	1	3	3	3	3	2	2	2	2	3	3	3	3	2	3	3	1	3	3	3	1	3	3	3	3	2	3	3

Notes:

(1) Develop appropriate score with AM Team

(2) Establish current scores based on interviews

(3) Assume criticality weighing between 1 (low) to 5 (high)

Priority

1 > 150

2 >100, <150

3 < 100

Optimizing

Managed

Defined Approach

Initial

Unaware

Continual improvement, refinement of processes, standards and procedures

Quantitative measurements are defined for processes and quality standards

Defined repeatable approach that is documented and communicated within the organization

Reactionary and without a systematic approach

Total unawareness within organization

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Attribute	Score	Asset Operation and Maintenance						Asset Condition Monitoring					Asset R&R					Asset Financing					Asset Financial Reporting					Asset Management Systems																	
		PM Definition	PM Scheduling	Corrective Maintenance	Maintenance Costs	Failure Codes Defined	Analysis Done to update Asset Plans	PM versus CM	Risk and Backlog	Inspection Considerations	Inspections	Condition Monitoring Methodology	Condition Rating and Scoring	Condition Tracking	Maintenance Scheduling	Corrective Actions	R&R Planning	R&R Alternatives	R&R Analysis	Life Extensions	R&R Costs	Audit of R&R Practices	Growth Needs	R&R Needs	Funding Plan	Funding Policy	Historical Trending	Consistency in Reporting	Change Management	Comprehensive Reporting	Budgeting with Objectivity	Cost Forecasting	Information System Plan	Data Collection Tools	Forecasting Tools	Standards and Protocols	System Integration Plan	Linked to Inventory /Stores	Linked to Budget/Performance Reporting	Linked to F/A System	GIS Functionality	Supports GASB 34 Depreciation Method	Supports GASB 34 Modified Approach	Change Management Process	
Optimizing	100																																												
	90																																												
	80																																												
Managed	70																																												
	60																																												
	50																																												
Defined Approach	40																																												
	30																																												
Initial	20																																												
Unaware	10																																												
Target Practice Score (1)		60	50	50	50	50	50	40	40	50	60	60	50	50	50	70	50	50	50	40	40	40	50	50	50	40	40	40	50	40	50	60	60	30	60	40	40	40	40	70	60	10	60		
Current Score (2)		30	30	40	30	30	20	30	30	50	60	30	40	30	30	30	40	30	30	30	10	30	30	50	30	30	20	30	40	40	30	60	50	20	60	20	10	10	10	70	60	10	60		
Gap		30	20	10	20	20	30	10	10	0	0	30	10	20	20	40	10	20	20	10	30	10	20	0	20	10	20	20	0	10	20	0	10	10	0	20	30	30	30	0	0	0	0		
Criticality (3)		5	5	5	5	5	5	4	4	5	5	5	5	5	5	5	3	3	3	4	3	4	4	4	4	4	5	4	4	4	4	4	4	4	3	4	4	4	4	4	4	1	4		
Weighted Gap (Criticality x Gap)		150	100	50	100	100	150	40	40	0	0	150	50	100	100	200	30	60	60	40	90	40	80	0	80	40	100	80	0	40	80	0	40	30	0	80	120	120	120	0	0	0	0		
Priority Ranking		1	2	3	2	2	1	3	3	3	3	1	3	2	2	1	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	2	2	2	3	3	3	3			

Priority

> 150

>100, <150

< 100

↑

Optimizing

Managed

Defined Approach

Initial

Unaware

Continual improvement, refinement of processes, standards and procedures

Quantitative measurements are defined for processes and quality standards

Defined repeatable approach that is documented and communicated within the organization

Reactionary and without a systematic approach

Total unawareness within organization

Appendix I: Asset Plan Template

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ASSET PLAN TEMPLATE

1. INTRODUCTION AND OVERVIEW

1.1. The classes and sub-classes included in the asset plan

- Drainage Basins
- Open Channels
- Stormwater Drains
- Stormwater Pits
- Best Management Practice

1.2. Quantitative data in respect of the asset classes and sub-classes, as applicable

- Number
- Length
- Area
- Volume
- Size

2. DESCRIPTION OF ASSETS COVERED BY THE PLAN

- 2.1. Age of stormwater system assets
- 2.2. Stormwater system asset materials
- 2.3. Stormwater system asset locations
- 2.4. Functionality of stormwater asset structures

3. SERVICE LEVELS

- 3.1. The expected or required service levels for the included assets
- 3.2. The actual service levels being achieved for the assets
- 3.3. Regulations and policies

Example – Asset Service Levels

Problem	Intervention Level	Remedy	Response Time
Blocked Drain	flow reduced by ?%	Remove Rubbish	? days
Broken Pit Lid	condition score = ?	Replace Lid	? days
Long grass in open channel	length > ?mm	Cut Grass	? days

Example - Regulations and Policies Affecting the Stormwater System

Regulation/Policy	Description
Regulations: Federal, State of Washington, Regional, and Local	
Clean Water Act	Provides for Water Pollution Control activities, including stormwater.
2013–2018 National Pollutant Discharge Elimination System Western Washington Phase II Municipal Stormwater Permit (NPDES Phase II Permit)	Provides for basic permitting requirements concerning the Phase II NPDES Stormwater Permit. Permit is authorized by the Washington State Department of Ecology.
Policies & Plans	
City of Shoreline Council Adopted Goals	Provides strategies, goals and budgets to achieve effective watershed management and control of stormwater runoff.
Shoreline Environmental Sustainability Strategy	
Shoreline Surface Water Master Plan	Document describing the management of the Surface Water Utility.
Stormwater Management Division – Maintenance Policies Dated 11-20-06	A description of the city urban drainage maintenance responsibilities.
Procedures	

4. FUTURE DEMAND (DERIVED FROM MASTER PLANNING)

- 4.1. Future requirements associated with Master plans or operational plans
- 4.2. Known or possible areas for expansion

- Asset classes and potential acquisition dates
- Cost estimates
- Impact on service levels, asset lifecycle and financial considerations

5. LIFECYCLE MANAGEMENT AND FINANCIAL CONSIDERATIONS

5.1. Useful Life

- Estimated length of time during which the asset is likely to be able to deliver a satisfactory level of service.

- May depend on a wide range of environmental factors
- The period over which a depreciable asset is expected to be used, or
- Estimated useful life for each asset class and sub-class
- Annual depreciation expense per asset class & sub-class

Example – Useful Life Table

Asset Sub-class	Useful Life	Average RUL	Annual Depreciation
Drainage Basins	? years	? years	\$?
Open Channels	? years	? years	\$?
Stormwater Drains	100 years	? years	\$?
Stormwater Pits	? years	? years	\$?
BMPs	? years	? years	\$?

5.2. Valuation of each asset class and sub-class

- Valuation
- Date of valuation and valuation methodology employed

Example – Asset Valuation Table

Asset Sub-class	Replacement Cost	Written Down Replacement Cost
Drainage Basins	\$?	\$?
Open Channels	\$?	\$?
Stormwater Drains	\$?	\$?
Stormwater Pits	\$?	\$?
BMPs	\$?	\$?

5.3. Operation and Maintenance Activities

- Operational activities
- Maintenance activities
- Description of program
- Timing of program
- Maintenance expense per asset class and sub-class

Example – Maintenance Expense Table

Asset Sub-class	Annual Maintenance Expenditure
Drainage Basins	\$?
Open Channels	\$?
Stormwater Drains	\$?
Stormwater Pits	\$?
BMPs	\$?

5.4. Condition Assessment and Monitoring Activities

5.5. Renewal/Replacement Plan

- Rehabilitation and replacement cycles and costs
- Capital Improvement Project (CIP) Planning
- Renewals capital expenditure

Example - Projected Stormwater Drainage Renewal Expenditure

Asset Sub-class	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Drainage Basins	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?
Open Channels	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?
Stormwater Drains	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?
Stormwater Pits	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?
BMPs	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?

5.6. Acquisition

- New or upgrade capital expenditure

Example - Projected Stormwater Drainage New and Upgrade Capital Expenditure

Asset Sub-class	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Drainage Basins	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?
Open Channels	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?
Stormwater Drains	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?

5.7. Disposal

- Proposed timing of asset retirement or disposal
- Estimated residual values at retirement or disposal

Example - Projected residual value of future stormwater drainage retirements & disposals

Asset Sub-class	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Drainage Basins	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?
Open Channels	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?
Stormwater Drains	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?
Stormwater Pits	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?
BMPs	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?	\$?

5.8. Risk Management

- Identification of risks
- Identification of risk mitigation strategies
- Stormwater system asset criticality matrix

5.9. Data Requirements and Tools

- Data requirements
- Document management
- Tools

6. ACTION PLAN

Appendix J: Asset Management Processes

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Prepared for: City of Shoreline

Project title: Shoreline Surface Water Master Plan

Project no.: 149479

Deliverable D13

To: Uki Dele **Date:** April 28, 2017

From: Scott Bash, FCS GROUP

CC: Nathan Foged, Brown and Caldwell

RE Asset Management Process and Framework

The intent of this memorandum is to provide guidance on how the Surface Water Utility may govern the asset management program and to recommend a framework for effective asset management.

ASSET MANAGEMENT FRAMEWORK

INTRODUCTION

Asset management (AM) is a structured approach to optimizing the life-cycle cost of asset ownership and focuses on providing reliable and dependable Surface Water Utility (Utility) service to customers of the City of Shoreline. The goal of an AM program is to meet customer needs and expected levels of service through sound fiscal planning and improved infrastructure management across the enterprise.

An enterprise AM program helps the Utility maintain its mission of protecting public health and the environment by improving the knowledge and management of assets. Two basic concepts of asset management are to maximize the useful life of assets and to reduce life-cycle costs. Measurement of asset performance and processes are key to sustaining the AM program. The cost of asset ownership must be well understood for informed decision making and all staff should be aligned with the best practices related to effective service delivery and meeting the desired business outcomes.

The Utility makes use of asset management, the supporting information technology, and financial performance data to manage the surface water assets and improve the organization's performance and costs. One of the goals of the AM program is to design and deliver practical programs that manage the life-cycle cost of asset ownership while improving asset reliability. The AM program requires an ongoing collaboration among the engineering, operations, maintenance, finance, and information

technology groups. Such a broad and coordinated program requires top management commitment, a cross-functional team approach, and an AM framework.

Figure 1 outlines the various elements of the framework in support of an enterprise AM program.

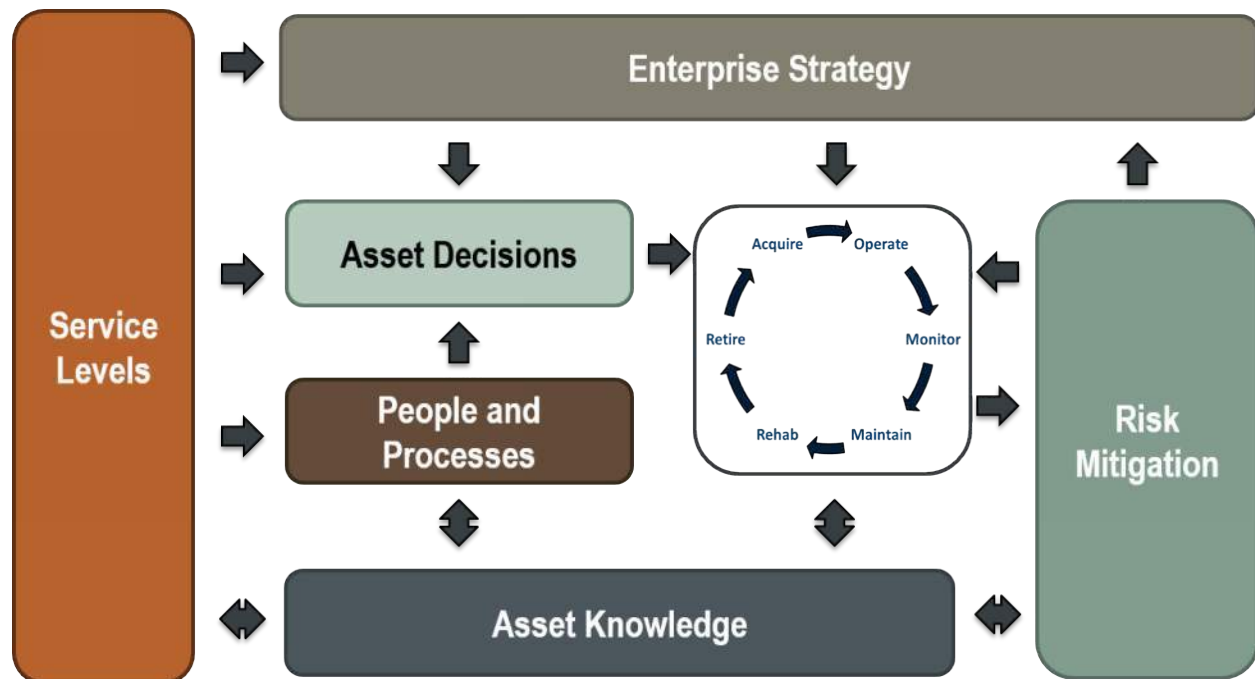


Figure 1: AM Framework

SERVICE LEVELS

Levels of service are the starting point for assessing the Utility's AM program. A customer service level is any utility service that a customer perceives as valuable that can be defined and measured. The strategy for developing levels of service is to clearly identify the current levels of service and come to an understanding with regulators, customers, and other stakeholders as to which service levels are prime obligations and which are targets to be met on a best-efforts basis. These service levels need to be updated as required so that they reflect the long-term interests of stakeholders.

Stakeholders should be kept informed of the performance of the Utility against its service levels and long-term cost targets. This ensures the ongoing reputation of the Utility and allows the Utility greater influence over its levels of service to its customers and the environment in the future.

A communications strategy is important for conveying service levels. The Utility should maintain a comprehensive communications strategy to keep its various stakeholders informed about meeting its service levels and long-term cost targets. Communication should be open and frequent. Special communication initiatives need to be devised on a proactive basis for special issues involving regulatory matters or changes in service levels.

ENTERPRISE STRATEGY

The Enterprise Strategy identifies the goals of the Utility and the approach for reaching those goals. It is a combination of strategies, each with an objective or set of objectives with specific measurable actions. These strategies should be with respect to the management of assets necessary to meet the level of service targets. The Enterprise Strategy is documented to explain how the individual strategies are implemented and managed. The Utility should develop a process of continual monitoring to allow for strategic plan updates as changes in the organization and environment occur.

Managing the regulatory environment is an important element of the Enterprise Strategy. The Utility works with regulators to achieve sound social, environmental, and economic outcomes for its communities. A regulatory management strategy should be developed for engaging with regulators and lawmakers on matters involving regulatory change. Whenever a rule or regulation is in development, it goes out for comment. The Utility should engage in the regulatory debate on federal matters mainly through its involvement in industry associations and comment directly on certain matters. The Utility should follow similar active engagement processes in dealing with proposed changes to state laws and the rules that affect them.

RISK MITIGATION

Risk mitigation is the process of developing options and actions to enhance opportunities and reduce threats to asset performance and enterprise strategy objectives. The idea of evaluating risk in asset management is to ensure that failure modes can be identified, acceptable levels of risk can be evaluated, critical assets and business processes are identified, consequences or failures are known, and risks are avoided or reduced.

For risk management of assets it is necessary to establish goals, objectives and strategies, and the scope of the risk assessment and management process. Without establishing goals and objectives, it will be difficult for the Utility to evaluate acceptable levels of risk. The Utility should develop a risk policy with a risk and criticality assessment related to assets being a part of the Operations and Maintenance (O&M) Strategies. The policy should break risk down into risk identification, risk analysis, and risk mitigation.

The Utility should maintain risk management policies, procedures, and practices by which assets and asset systems are identified and ranked according to their level of criticality. If the asset were to fail to fulfill its function, the worst-case credible scenario should be used to establish this risk ranking.

Based on the criticality ranking, the appropriate risk management methodology should be applied in order to determine the risk score of the asset or asset system, based on consequence and likelihood of a loss event. This risk score should be set up such that it can be expressed in a current measurable risk exposure. The organization should be able to aggregate the risk exposure at various levels or across various dimensions of the asset source of record.

Based on asset risk score, the organization should apply the appropriate risk assessment and treatment methodology to determine the appropriate level of risk mitigation. This typically involves understanding the possible failures and potential for degradation of assets in enough detail to determine the measure of exposure to a probabilistic loss event. Mitigating actions and events are then prescribed in order to arrive at a treatment plan that measurably reduces risk. This process should also track the cost of these actions

and events so that life-cycle cost estimates can be analyzed. The Utility can then use the cost to reduce risk exposure to calculate a risk return on investment.

A risk mitigation evaluation should include exception criteria. These help detect deviations in expected performance metrics. In addition, it is important to have performance analysis in place. Performance analysis is used to monitor compliance to prescribed risk mitigation actions and events. Performance analysis should also include condition assessments done in order to monitor for changes in asset health. Finally, exception criteria should also consider performance requirements of the asset in terms of units of production, availability, or utilization.

ASSET DECISIONS

Asset decisions should be documented and follow a repeatable process. A decision-making process is developed and accepted at the Utility and should outline the threshold for which asset decisions require a business case evaluation (BCE) in order to obtain approval, the process for approval of asset decisions below the threshold, and the process for approvals within the BCE process. The BCE process is implemented at the Utility so that all capital and operating decisions are made in a documented and structured way. The BCE process should be well documented, and the process participants should have training in the use of the process. Roles and responsibilities for decision making should be documented so that all Utility staff are aware of the steps in obtaining approval for capital and operating decisions regarding assets.

Asset Plans

An asset plan is a road map to asset ownership costs, expressing best estimates of these costs throughout the entire asset life cycle. In addition, the asset plan includes O&M strategies for the asset as well as rehabilitation and replacement (R&R) plans. Asset plans should be used to give the Utility a snapshot of important information concerning an asset. The asset plans for the assets owned and operated by the Utility should be kept in an electronic database system. The asset plans should be kept up to date using electronic systems, and the plans should be produced in hard copy for workers unable to access a computer. The Utility should use asset plans in the building of facilities, such as those produced by BCE, to provide the basis for more detailed O&M strategies and R&R plans. Once facilities are in operation, it should measure and periodically compare actual ownership costs with forecasted costs to improve future forecasts. The Utility should measure its actual ownership costs for existing facilities and prepare similar asset plans for these facilities.

Asset Financing

The Utility's asset financing strategy includes life-cycle planning, decision making, and financial management components. Better knowledge of future capital needs and future O&M costs will improve the quality and dependability of the Utility's business plan and better document the Utility's future funding needs. It is important for the Utility to understand its costs well enough to make defensible estimates of future costs so that proper budgets can be prepared and resources can be properly allocated. Improved cost forecasting allows for improved management of assets through the decision-making process. Better forecasting of asset replacement costs over several years will help the Utility better identify future funding needs and better control rates. Policies that balance R&R against new projects and improvements will result in more control over rate fluctuations.

ASSET LIFE CYCLE

This section summarizes key milestones in the asset life cycle, including acquire, operate, monitor, maintain, rehabilitate, and retire.

Acquire

The new asset development strategies employed by the Utility should be used to gain the best cost and project outcomes. The project outcomes are measured by project cost and project timelines. Projects should be bundled to get cost and contracting advantages, when practical. The new asset acquisition strategies for routine asset replacements should be well developed for different asset/equipment types, taking into account the project risk profile.

Operate

The operations strategies employed by the Utility should be used to ensure that the cost, reliability, and service levels for the Utility assets are met. The strategies employed should be developed using the risk profile of each facility and piece of equipment, and every hierarchical level in between. The operating strategies of the assets should be developed so that the asset reliability is maintained according to the asset's risk profile. These strategies take into account the remote monitoring and control available at each of the assets and consider the monitoring design versus the actual set points.

Monitor

The Utility should use condition monitoring for assets to predict failure and intervene before catastrophic failure. Condition monitoring techniques should be employed only where it can be suitably justified; i.e., where the cost of the technique is less than the cost of the asset failure. Methods of monitoring asset condition vary according to the asset class. Once the ways in which an asset can fail are defined, monitoring methods can be chosen to predict failures. The scoring system should reflect the asset condition and allow for comparative analysis and consequence-of-failure analysis. Condition assessments and trends in assessments are normally used to support maintenance scheduling, prediction of R&R timing, and decisions on R&R actions.

Maintain

A maintenance strategy should be developed after understanding the risk profile of a facility or piece of equipment. The maintenance options should be categorized as run to failure, condition-based maintenance, or preventive maintenance (PM) (calendar-based or run-based) with an analysis of the maintenance costs for all Utility assets performed annually. The cost analysis should be done by analyzing each PM task and by looking at the frequency and effort required. Each task should be coded by the type of labor needed to carry out the task. Changes to the operator's or maintainer's maintenance program should be redesigned accordingly to improve asset reliability.

Rehabilitate

Asset replacements should be done within well-defined strategies for different asset classes and within different operating risks. Replacements should take into account obsolescence and efficiency and be complementary to long-range planning efforts. The strategies for routine asset replacements should be translated into decision support models that ensure that decisions are consistent and made in a timely manner. The approach taken to identify assets for R&R is to look broadly at the

performance of the electrical/mechanical asset base and rank equipment according to selected parameters such as rate of failure or reactive maintenance costs. This ranking will generate a prioritized list of equipment, which should be subjected to further economic evaluation.

Retire

The Utility should itemize its assets in accordance with the established hierarchy and at a level of detail that supports its normal business processes. When assets are retired because they are either disposed of or no longer in use, all databases and necessary journal entries to remove the asset's financial information should be updated. The retirement should be part of the asset plan and a record for each asset should be maintained, as necessary, for asset planning and for making asset decisions such as determining optimal maintenance intervals and actions, timing and types of capital refurbishments, and timing of retirements/replacements. The Utility should review and document its processes for informing Administrative Services of asset retirements or replacements. These processes should be strengthened, if necessary, with the advice of the finance section. Criteria for capitalization and retirement review as well as how the review conduct should be conducted.

PEOPLE AND PROCESSES

The Utility should develop a systematic approach for educating and motivating the workforce to generate both direct and indirect value for the AM program. The objective of an education strategy is to encourage innovation, problem solving, and skills improvements at all levels of the Utility. Skilled and knowledgeable staff require an investment in training. This investment leads to improvement in service, which leads to public trust. Trust leads to better relationships with customers and stakeholders, which will be necessary to support the goals of the Utility. The education and development program for all staff involved in the AM program should be based on their specific roles and responsibilities.

Continuous Improvement

Continuous improvement should include quality assurance (QA) plans and procedures and will provide the framework for ensuring that all AM processes and procedures implemented at the Utility are monitored for improvement. The Utility should annually audit its AM program in an effort to ensure continual improvement and provide quality assurance that procedures and processes are implemented. A program should be developed that defines the Utility audit procedure for the AM program. The program will allow for reviews of the quality procedures in place at the Utility, define roles and responsibilities, and define the corrective action process.

Knowledge Sharing

Knowledge sharing supports the strategic framework of the AM program and involves the information systems, data, and manner in which staff uses information and coordinates activities. The Utility should develop a knowledge-sharing program as an essential part of measuring organizational success. The knowledge-sharing strategy is a combination of data, processes, and software technology strategies. Data are used to support the management of organizational goals, business processes, business interactions, and the workflow of individual performers. Hardware and software technology will vary based on application needs to meet the strategic goals. Standards should be maintained at all times to document user needs and integration requirements.

ASSET KNOWLEDGE

Asset knowledge is critical to achieving good AM outcomes. Knowledge of the operating assets of the Utility is captured through asset hierarchies and asset inventories in the Cityworks computerized maintenance management system (CMMS) and geographic information system (GIS). The use of CMMS and GIS to capture this information allows asset managers to understand their assets from any level and equipment performance across multiple installations. Assets should be classified to enable the Utility to compare the performance of assets of similar types. The asset classification process should be well defined and documented (for example, bioretention facilities could be an asset class, pumps could be an asset class, stormwater pipes by materials could be an asset class, etc.).

The Utility should understand its assets' costs and reliability through data access and knowledge sharing. All assets should be given a minimum performance limit and targeted for a desired level of performance. Failure codes are used to help measure an asset's reliability and are useful in the analysis of data. The tendency is to grow the selection of available codes with unique identifiers to cover each specific instance of failure, which makes analysis very difficult. The number of available codes in the list should be limited as much as possible.

PERFORMANCE MEASURES

The effectiveness of the AM program can be measured in the following three major ways:

- 1) The degree to which the required cash flows identified in the Surface Water Master Plan are incorporated into the City Council's long-term financial plan
- 2) The degree to which 1- to 6-year detailed capital works programs, budgets, business plans, and organizational structures take into account the AM work plan
- 3) Measure of key performance indicators (KPIs) that track the level-of-service targets

The levels of service and KPIs are the primary measures of performance. KPIs are used to drive business improvements and will ultimately lead to changes in the AM program. For purposes of continual improvement, the AM program should be refined with improvements to standards and procedures as deemed necessary to improve and to meet program goals.

Each of the defined service levels should have KPIs or metrics in order to determine if each service level was met. These metrics should be coordinated with other Utility programs and City Council goals. The Utility should continually update and document both external and internal service levels. For each of these service levels, a KPI or similar metric can be assigned in order to measure the performance of the service level. On an annual basis, an audit should be conducted to determine if these KPIs were achieved during the year. Corrective action plans can then be developed as a result of this audit, if KPIs were not achieved for the service levels.

GLOSSARY

Term	Definition
Asset	A physical component of a facility that has value, enables services to be provided, and has an economic life of greater than 12 months. Dynamic assets have some moving parts, while passive assets have none.
Asset class	A set of assets with similar characteristics that can be treated similarly when estimating R&R requirements.
Asset hierarchy	A framework for segmenting an asset base into appropriate classifications. The asset hierarchy can be based on asset function, asset type, or a combination of the two.
Asset management (AM)	A program to minimize costs of asset ownership while managing risks and meeting required service levels.
Asset plan	A road map to asset ownership costs, expressing best estimates of these costs throughout the entire asset life cycle.
Asset management program manager	The person appointed by an organization to ensure that corporate AM goals, objectives, and legal obligations are met. The AM program manager may also be required to lead the AM team.
Asset management information system	An AM system is a combination of processes, data, and software applied to provide the essential outputs for effective AM such as reduced risk and optimum infrastructure investment. A computerized maintenance management system (CMMS) is an example of an asset management information system.
Asset management strategy	A strategy for asset management covering the development and implementation of plans and programs for asset creation, operation, maintenance, R&R, disposal, and performance monitoring to ensure that the desired levels of service and other operational objectives are achieved at optimum cost.
Asset management team	The team appointed by an organization to review and monitor the corporate AM improvement program and ensure the development of integrated AM systems and plans consistent with organizational goals and objectives.
Asset register	A record of asset information considered worthy of separate identification including inventory, historical, financial, condition, construction, technical, and financial information about each.
Business case evaluation (BCE)	A process to determine the need for and best configuration of a capital project in terms of service levels, economics, and risk.
Business plan	A plan produced by an organization (or business units within it) that translates the objectives contained in an annual plan into detailed work plans for a particular, or range of, business activities. Activities may include marketing, development, operations, management, personnel, technology, and financial planning.
Capital expenditure	Expenditure used to create new assets or to increase the capacity of existing assets beyond their original design capacity or service potential. Capital expenditure increases the value of asset stock.
Component	A specific part of an asset having an independent physical or functional identity and having specific attributes such as different life expectancy, maintenance regimes, risk, or criticality.
Condition assessment	The process of evaluating an asset to estimate its remaining useful life, or probability of failure. Assessments are tied to asset failure modes and are usually expressed numerically.
Condition-based maintenance	Maintenance initiated as a result of knowledge of an item's condition from routine or continuous monitoring.
Condition monitoring	Continuous or periodic inspection, assessment, measurement, and interpretation of the resultant data, to indicate the condition of a specific component so as to determine the need for some preventive or remedial action.
Corrective maintenance	The remedial actions performed as a result of failure, to restore an item to a specified condition. Corrective maintenance may or may not be scheduled.
Critical asset	An asset for which the financial, business, or service level consequences of failure are sufficiently severe to justify proactive inspection and rehabilitation. Critical assets have a lower threshold for action than non-critical assets.

Term	Definition
Criticality	A numerical measure of the potential consequences of an asset's unexpected failure in terms of service levels, community cost, safety, etc.
Data warehouse	A system that is used to centralize a group of disparate databases in an organization to facilitate access into each of those databases.
Depreciation	The wearing out, consumption, or other loss of value of an asset whether arising from use, passing of time, or obsolescence through technological or market changes. It is accounted for by the allocation of the cost (or revalued amount) of the asset less its residual value over its useful life.
Disposal	The sale or other ultimate disposition of an asset that has been demolished or replaced. Also includes the activities necessary to dispose of decommissioned assets.
Economic life	The period from the acquisition of the asset to the time when the asset, while physically able to provide a service, ceases to be the lowest-cost alternative to satisfy a particular level of service. Economic life is at a maximum when equal to the physical life; however, obsolescence will often ensure that economic life is less than physical life.
Facility	A complex comprising many assets (e.g., a hospital, water treatment plant, recreation complex, etc.) that represents a single management unit for financial, operational, maintenance, or other purposes.
Failure modes, effects, and criticality analysis	A technique for analyzing and evaluating a design to ensure that the application has the desired reliability characteristics by preventing those critical failure modes through employment of redundancy, providing alternate modes of operation, de-rating, or any other means.
Gap analysis	A method of assessing the gap between a business's current AM practices and the future desirable AM practices. Also called needs analysis or improvement planning.
Geographic information system (GIS)	Software that provides a means of spatially viewing, searching, manipulating, and analyzing an electronic database.
Key performance indicator (KPI)	A qualitative or quantitative measure of a service or activity used to compare actual performance against a standard or other target. KPIs commonly relate to statutory limits, safety, responsiveness, cost, comfort, asset performance, reliability, efficiency, environmental protection, and customer satisfaction.
Level of service	The defined service quality for a particular activity or service area against which service performance may be measured. Levels of service usually relate to quality, quantity, reliability, responsiveness, environmental acceptability, and cost.
Life	A measure of the anticipated life of an asset or component, such as time, number of cycles, distance intervals, etc.
Life cycle	The cycle of activities that an asset (or facility) goes through while it retains an identity as a particular asset; i.e., from planning and design to decommissioning or disposal.
Life-cycle cost	The total cost of owning an asset over its useful or economic life including planning, design, acquisition, O&M, periodic reinvestments, condition monitoring, etc. The life-cycle cost can be expressed as a single cost in today's dollars using present value. The total cost of an asset through its life including planning, design, construction, acquisition, operation, maintenance, rehabilitation, and disposal costs.
Life-cycle cost analysis	Any technique that allows assessment of a given solution, or choice from among alternative solutions, based on all relevant economic consequences over the service life of the asset.
Maintainability	A characteristic of the design of an installation, usually identified by the required amount of time of an effort to retain an asset as near as practicable to its new or desired condition within a given period.
Maintenance	All actions necessary for retaining an asset as near as practicable to its original condition, but excluding rehabilitation or replacement. Fixed-interval maintenance is used to express the maximum interval between maintenance tasks.
Maintenance strategy	Collated information, policies, and procedures for the optimum maintenance of an asset or group of assets.
Maintenance standards	The standards set for maintenance service, usually contained in preventive maintenance schedules, operations and maintenance manuals, codes of practice, estimating criteria, statutory regulations, and mandatory requirements, in accordance with maintenance quality objectives.

Term	Definition
Net present value	The value of an asset to the organization, derived from the continued use and subsequent disposal in present monetary values. It is the net amount of discounted total cash inflows arising from the continued use and subsequent disposal of the asset after deducting the value of the discounted total cash outflows.
Operation	The active process of utilizing an asset that will consume resources such as manpower, energy, chemicals, and materials. Operation costs are part of the life-cycle costs of an asset.
Operations and maintenance (O&M)	The normal day-to-day activities to operate, maintain, and repair an infrastructure system. O&M activities are usually funded from the operating budget and treated as current-period expenses in financial reporting.
Performance monitoring	Continuous or periodic quantitative and qualitative assessments of the actual performance compared with specific objectives, targets, or standards.
Planned maintenance	Planned maintenance activities fall into three categories: <ol style="list-style-type: none"> 1. Periodic: necessary to ensure the reliability or to sustain the design life of an asset 2. Predictive: condition monitoring activities used to predict failure 3. Preventive: maintenance that can be initiated without routine or continuous checking (e.g., using information contained in maintenance manuals or manufacturers' recommendations)—not condition-based
Present value (PV)	The time-adjusted value of a series of cash flows, expressed as a single number in today's dollars. The discount rate is used for the time adjustment.
Preventive maintenance (PM)	An asset intervention that sustains the condition and functionality of an asset on a short-interval basis, as distinct from repair (see following). PM is an O&M activity (see previous).
R&R	Rehabilitation and replacement (see following).
Rehabilitation	Works to rebuild or replace parts or components of an asset, to restore it to a required functional condition and extend its life, which may incorporate some modification. Rehabilitation generally involves repairing the asset to deliver its original level of service without resorting to significant upgrading or renewal, using available techniques and standards.
Reliability-centered maintenance	A process for optimizing maintenance based on the reliability characteristics of the asset.
Remaining economic life	The time remaining until an asset ceases to provide the required service level or economic usefulness.
Repair	An action to restore an item to its previous condition after failure or damage.
Replacement	The removal from service of an asset and substitution with a new asset of the same asset class. The complete replacement of an asset that has reached the end of its life to provide a similar, or agreed alternative, level of service.
Replacement cost	The cost, actual or expected, of an asset replacement. The cost of replacing an existing asset with a substantially identical new asset.
Retirement	The physical removal of an asset from service.
Risk cost	A fundamental cost of asset ownership, normally expressed in dollars per year. It is the product of the direct and community cost of unexpected asset failure and the probability of failure per year. The assessed annual cost or benefit relating to the consequence of an event. Risk cost equals the costs relating to the event multiplied by the probability of the event occurring.
Risk management	The application of a formal process to the range of possible values relating to key factors associated with a risk to determine the resultant ranges of outcomes and their probability of occurrence.
Routine maintenance	Day-to-day operational activities to keep an asset operating (replacement of light bulbs, cleaning of drains, repairing leaks, etc.) and that, for part of the annual operating budget, include preventive maintenance.
Service level	Any utility service that a customer perceives as valuable, as defined and measured. A mature AM organization understands the service levels its customers (or the environment) require and manages itself to meet those service levels at the lowest cost.

Term	Definition
Strategic plan	A plan containing the long-term goals and strategies of an organization. Strategic plans have a strong external focus; cover major portions of the organization; and identify major targets, actions, and resource allocations relating to the long-term survival, value, and growth of the organization.
Useful life	<p>The interval between the time an asset is placed in service and the expected date of replacement. The total useful life of an asset in service may increase over time because of standard mortality considerations, although remaining useful life may continue to decline.</p> <p>May be expressed as either: (1) the period over which a depreciable asset is expected to be used, or (2) the number of production or similar units (i.e., intervals, cycles) that is expected to be obtained from the asset.</p>

Appendix K: Utility Billing

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Prepared for: City of Shoreline
Project title: Shoreline Surface Water Master Plan
Project no.: 149479
Deliverable D13

To: Uki Dele, City of Shoreline
From: John Ghilarducci, David Gordon, FCS GROUP
CC: Margaret Ales, Nathan Foged, Brown and Caldwell
RE Stormwater Utility Billing System Audit

SUMMARY

Brown and Caldwell and FCS Group (Consultant Team) are working with the City of Shoreline (City) to prepare an updated Surface Water Master Plan (Master Plan) for the Surface Water Utility (Utility). This memorandum summarizes the results of Task 8.1: Audit Utility Billing System of the Master Plan, which is an audit of King County's (County's) surface water management utility billing system, used by the City to charge City stormwater rates.

We compared data used by the County to determine and charge surface water fees with City geographic information system (GIS) data on chargeable area. We discovered few major differences between the two data sets and have calculated the potential revenue impact from comparable data as less than 2 percent of total annual expected revenues (with the County data currently resulting in higher revenues).

We also analyzed the processes for updating surface water data. This process reveals gaps in the City's methods for updating impervious-surface information. Currently, updated impervious-surface data are received only for new commercial and residential parcels. Currently (and historically), changes in impervious-surface information due to development have not been recorded. This raises the need to determine a path forward for assessing the accuracy and completeness of historical data as well as to change data-recording procedures to collect and distribute new impervious-surface information.

INTRODUCTION

The purpose of this task is to review the accuracy and completeness of the County's billing of City surface water rates. The County uses spatial and tax parcel data to calculate and bill Shoreline residents and businesses appropriate stormwater fees. The City provides the County with updated parcel information via the City Planning and Community Development Department (PCD). The County also requests parcel updates from the City prior to billing customers.

Although successful information sharing between the County and City already exists, it is important to audit the current billing information to ensure accuracy, identify problems, and ensure that processes going forward guarantee the correct billing of City stormwater utility customers.

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METHODOLOGY

We performed this audit of County surface water billing by comparing existing City GIS data with the most recent customer billing information provided by the County. When comparing data sets, we searched for the following information:

- ◆ **Parcel matches:** This checks to see if parcels in the City data set are in the County data set and highlights if and where data may be missing from either data set.
- ◆ **Parcel classifications:** This determines if the data sets share accurate information on the type of parcel and its account status.
- ◆ **Impervious surface:** Except for residential-classified parcels, impervious surface is extremely important in determining the correct service charge. We compare impervious-surface data by tax identifier (ID) for both data sets.
- ◆ **Billing:** Using the prior data checks, we can compare expected and actual bill amounts and determine if and how data differences influence revenue.

In addition to comparing the data sets, we researched how the County and City update important parcel information. This information is vital in determining how data inaccuracies may be reconciled in future processes.

The City's goal is to make this audit repeatable by City staff in the future. Toward that effort, our analysis uses set equations in Excel to compare and analyze data sets. The City can use this Excel file, with updated information, to perform future audits of the billing data. This file is submitted separately and is titled, "Combined Data 20170428.xlsx".

ANALYSIS

Comparisons of the City's and County's surface water data reveal differences that are largely explainable and, based on the current rate structure, of minimal impact to potential revenues.

PARCEL MATCHES

There is a strong correlation between parcels in the County data set and those in the City's data set. Table 1 compares the account status for City and County data sets.

Table 1: Account Status by Data Source

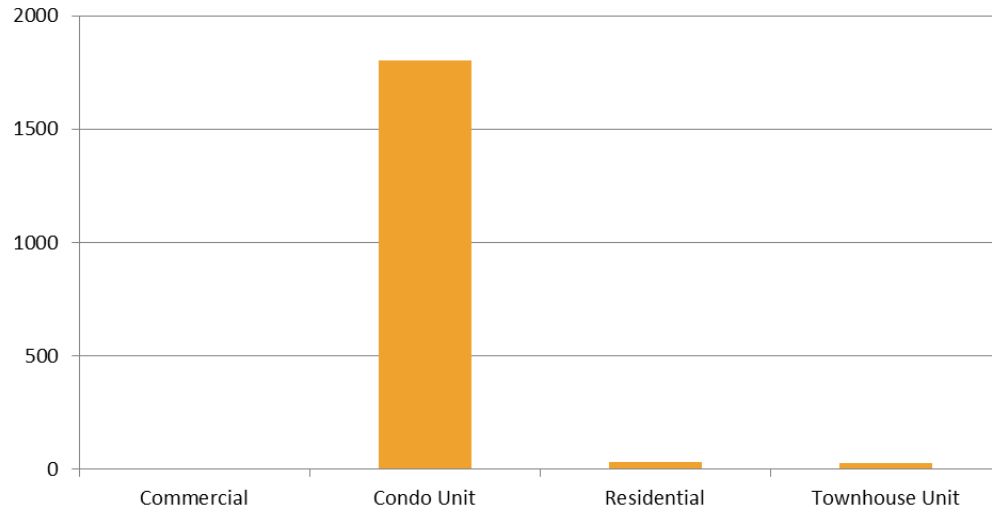
County Account Status	City GIS Account Status		
	Active	Suspended	Not in City
Active	17,034		1,865
Suspended		121	2
Undeveloped	1		
Not in County	398	6	

About 10 percent of all parcels listed in both data sets do not match. This means that a parcel in one

data set does not exist in another.

The great majority of these unmatched parcels exist in the County's data set and not in the City's. These unmatched parcels are almost entirely condo units. Each unit is billed separately by dividing the complex's total bill (based on size and impervious surface) by the number of units in that complex. See Figure 1.

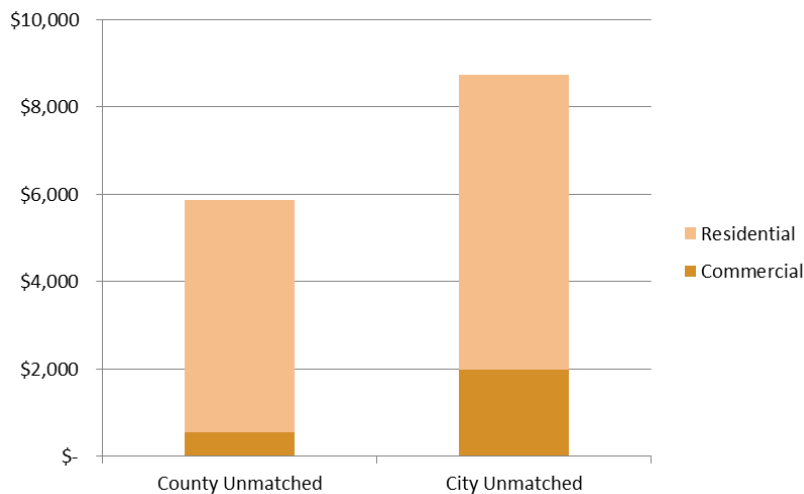
Figure 1: County Unmatched Parcels by Account Type



Of the 400 parcels that exist in the City's data set and not in the County's, the majority are of an unknown category. These are difficult to decipher, but reflect the condo and townhouse complexes expressed as units in the County data.

Residential and commercial properties make up the remainder of unmatched parcels. Analyzing only these parcels by the expected annual fees they should produce shows that the County data may be missing approximately \$3,000 in annual fees. This is shown in Figure 2.

Figure 2: Unmatched Parcels by Fee Total



Because the impact of known mismatched parcels is low, there are no significant findings when considering unmatched parcels.

PARCEL CLASSIFICATIONS

Now considering only matched parcels, those that do appear in both data sets, it is important to determine if the parcel rate classes are similar. Different rate classes have significant impacts on expected revenue. Under the current fee structure, there are seven rate categories. The first category is for single-family residential parcels. These parcels are charged a flat fee. The remaining rate categories are distinguished by percent impervious surface. Variations in parcel classifications could lead to significant differences in expected revenue.

We completed this analysis by comparing the rate class already listed in the County's data with a calculated rate class from the City that was based on calculated impervious-surface percentages and residential classifications.

Table 2: Parcel Classification Match

City Calc. Rate Class	County Rate Class						
	Residential	Very Light	Light	Moderate	Moderately Heavy	Heavy	Very Heavy
Residential	94.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Very light	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
Light	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%
Moderate	0.0%	0.0%	0.0%	0.3%	0.1%	0.1%	0.0%
Moderately heavy	0.0%	0.0%	0.0%	0.1%	0.5%	0.3%	0.2%
Heavy	0.0%	0.0%	0.0%	0.1%	0.2%	0.6%	0.8%
Very heavy	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	1.1%

The green highlighted cells in Table 2 show where parcel classifications match. Matches occur for 97.5 percent of data and almost all residential classifications. Classification differences that do exist are a result of different calculated impervious-surface percentages for both data sets.

IMPERVIOUS SURFACE

Although rate classes largely match for both data sets, it is important to analyze impervious-surface data. If the City were to calculate surface water fees using more detailed impervious-surface data, instead of the current bucketed approach, these differences could lead to significant revenue differences. We performed this analysis using both total impervious acreage and percent impervious surface.

Figure 3: Impervious-Surface Analysis

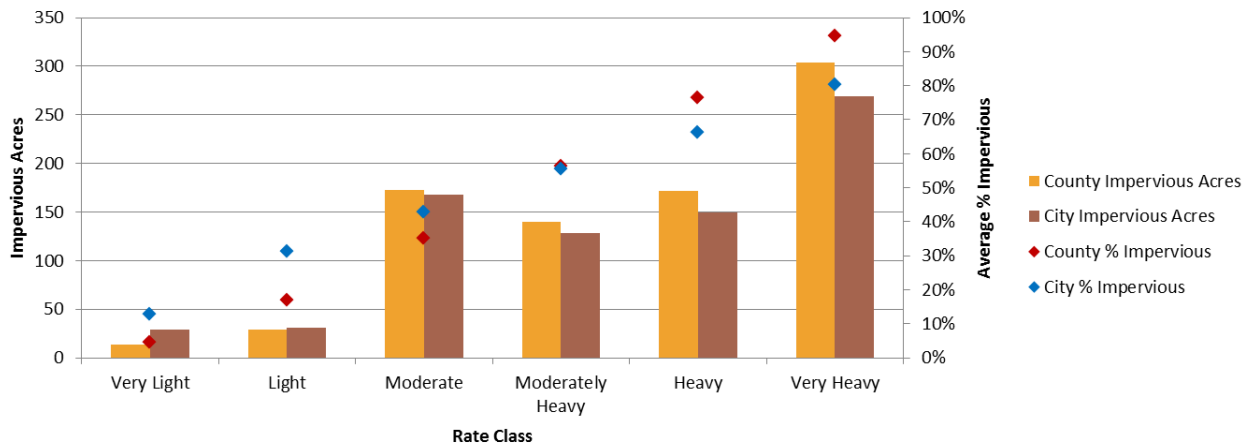


Figure 3 shows the results of this analysis. At the lowest levels of impervious-surface coverage, City data skew slightly higher in both total acreage and average impervious-surface coverage. At higher tiers, this trend flips and the County's data show both higher overall impervious-surface coverage and average rate of impervious-surface coverage. Such a unique trend in the data may mean that the method or data source for initially calculating impervious-surface coverage is different between the two data sets.

Despite these differences, the data remain close. It is currently not possible to monetarily quantify the impact of these differences unless the City adopts a different rate structure outside of the current tiered system used by the County. If the City were to consider a system that uses precise impervious-surface data to calculate a fee (instead of using data to place properties in buckets), these differences could be quantified monetarily.

BILLING

Under the current tiered fee structure, we can compare the calculated rates for both data sets and determine the fiscal impact of one data set over the other.

The challenge in this comparison is that the billing data provided by the County incorporate discounts without expressly naming these discounts. A first glance at the data appears to show that the County undercharges for services. However, removing these discounts and calculating the fee separately for both data sets shows highly similar annual revenue expectations.

Figure 4: Comparing Billing Data

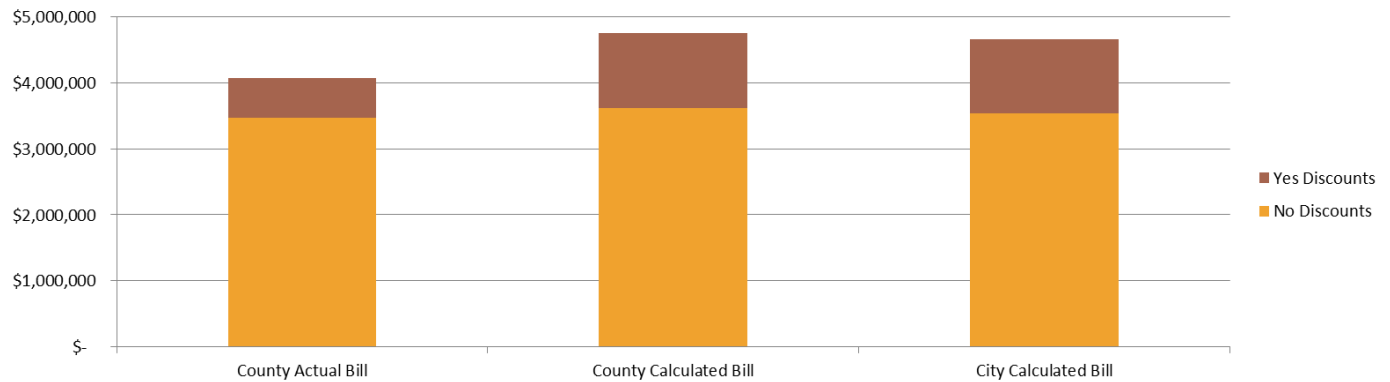


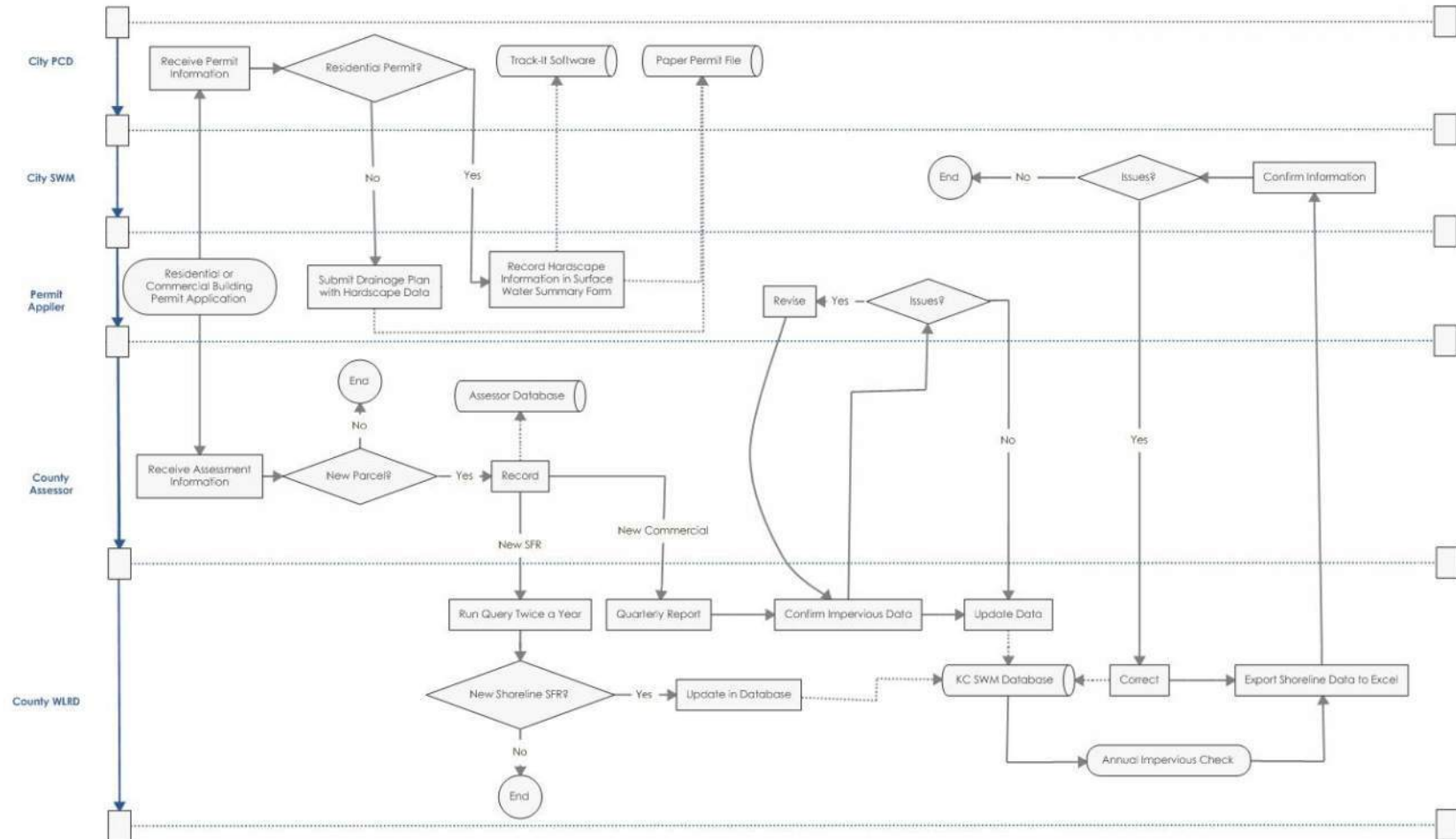
Figure 4 shows three columns. The column on the left shows the actual billed fee revenue as recorded by the County. The other two columns show calculated fees using rate classes for County-only data and City-only data. This figure compares only matching parcel data. Each column comprises billing data with and without discounts.

Differentiating the discounted and non-discounted parcels in the billing data shown in Figure 4 helps to reveal very similar revenue expectations for both data sets. The calculated County annual revenue is approximately \$80,000 higher than the City's calculated revenue. This represents approximately 2 percent of total expected revenue.

DATA FLOW

The City and County rely on each other to ensure that surface water data are appropriately updated prior to each billing cycle. Our analysis shows that while there is ample opportunity to share and record updated impervious-surface information, this generally does not occur. Figure 5 shows the current process flow for impervious-surface information for Residential and Commercial building permits.

Figure 5: Impervious-Surface Data Process Flow



PROCESS DESCRIPTION

Updates to hardscape information for a parcel occur when an individual applies for a permit that requires hardscape data inputs. PCD requires hardscape, not impervious-surface, information.

This process generally occurs for a Residential Building or Commercial/Multi-Family Building permit. The individual provides the hardscape data via the permit application. For Residential Building permits, this occurs within the Medium Impact or Small Impact surface water summary forms. For Commercial/Multi-Family Building permits, hardscape data can be found in the individual drainage engineering plans.

The City then records this information via a paper filing system as well as the Track-It software¹. These data are not subsequently sent to the Surface Water Management group, nor are they sent to the County.

If the permit has relevance to the County Assessor's office, the applier will also send information there. No impervious-surface data are shared through this process. If the permit involves a new parcel (commercial or residential), this information is recorded and eventually sent to the County's Water and Land Resources Division (WLRD).

For new commercial parcels, the WLRD will use existing submitted permit information to confirm impervious surfaces. This information is checked with the applier and corrections are made as necessary. Once confirmed, the information is added to the billing database. For new single-family residential parcels, the WLRD updates its billing database to ensure that these parcels are recorded so they can be billed.

Before billing surface water customers, the WLRD checks with the City to ensure that all impervious-surface and parcel data are correct. Information is submitted via an Excel spreadsheet to the City. The City then has the opportunity to correct any issues it finds. Historically, the City has not used this opportunity to update impervious-surface data.

ISSUES IDENTIFIED FROM PROCESS ANALYSIS

Although there is ample opportunity to collect and share information, impervious-surface data are not currently being updated via information provided to the City. The only form of impervious-surface data updates comes from new parcel information provided by the County. Particular process issues include:

¹ The Track-It software is new and its relationship with hardscape information generally applies to Residential Building permits only. There is a line in the Residential Building permit to include hardscape information. Previously the City used Hansen. Hardscape data were not individually recorded here.

- ◆ **Currently collected permit data not used by City:** Although the County requests parcel updates from the City prior to billing, the City does not provide any updates on impervious-surface data.
- ◆ **Data gathering does not lend itself to queries:** Even though the City has important information within permits and plans, the information is not currently gathered in a way that would lend itself to simple queries. This is because Commercial/Multi-Family Building permits do not have a field for recording hardscape data within Track-It.
- ◆ **Historical data are unused and not readily accessible:** The County updates impervious-surface data for new commercial parcels. Unless construction involves a new parcel, revised impervious-surface data will not have been incorporated into surface water billing. These data may be accessible in physical plans within permits, but this cannot be easily queried.

FINDINGS AND RECOMMENDATIONS

Our analysis of available County and City data reveals no significant differences that would necessarily merit further investigation into missing or inaccurate data. The current level of data discrepancies shows that, at some level, the data sets are different. However, these are predominantly minor and largely explainable.

Further inquiry into detailed impervious-surface data may be warranted if the City decides to change its fee structure in a way that would use the accuracy of impervious-surface coverage information. However, our analysis of available data shows that the City should not expect large differences between the County and City data.

Of greater importance is the ability of the City to check the accuracy of its own data and communicate data updates to the County. There may be a high correlation between County and City data, but this does not mean that the data are accurate.

Improving the internal accuracy of data requires the following two actions:

- ◆ **Emphasize stormwater data needs in PCD:** The City should work with PCD to ensure that impervious-surface data needed for billing are collected in a manner that is accurate and easily queried. This requires two steps: (1) ensuring that the appropriate “impervious-surface” data are collected, not just hardscape data, and (2) the City must record updated impervious-surface data within the Track-It system for applicable permits by adding a field in the software as well as implementing a new process so planners know to input this information.
- ◆ **Review the accuracy of historical information to perform a business case on further data collection:** Improved planning data help data accuracy only for new projects. Historical inaccuracies may or may not be an issue for the City. Depending on the scale of the issue, and the rate structure ultimately used by the City, the level of effort for correcting historical data may vary. The City should analyze if historical data are at a level of imprecision to warrant new or different historical data collection. This will likely require a high level of effort as historical data for commercial and multi-family residential properties are located within plans, not within Track-It or the prior system, Hansen.

Appendix L: Financial Planning

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City of Shoreline

Surface Water Utility

Financial Analysis for 2018 Master Plan

FINAL REPORT
November 2017

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Section I. INTRODUCTION

This financial plan is intended to ensure the viability of the surface water management program during the six-year planning period (2018 to 2023). It considers the historical financial condition, current and identified future financial and policy obligations, operations and maintenance needs, and the capital projects identified in the updated Surface Water Master Plan. **Appendix A** presents backup documentation related to this financial plan.

The City's Surface Water Utility (Utility) is responsible for funding all of its costs. The primary source of funding is a surface water fee that is billed on the County property tax statement. Nominal additional revenues are generated through interest earned on reserves. The City controls the level of user charges and, subject to City Council approval, can adjust user charges as needed to meet financial objectives.

The financial plan considers both operating and capital requirements to assess total system cost. This is accomplished through two elements:

- **Capital Funding Analysis.** Identifies the total capital improvement plan (CIP) obligations of the planning period. The plan defines a strategy for funding the CIP including an analysis of available resources from rate revenues, existing reserves, debt financing, and any special resources that may be available (e.g. grants, developer contributions, etc.). The capital funding plan impacts the financial plan through the use of the assumed rate revenue available for capital funding.
- **Financial Forecast.** Identifies future annual non-capital costs associated with the operating, maintenance and administration of the surface water system. Included in the financial plan is a reserve analysis that forecasts cash flow and fund balance activity along with testing for satisfaction of actual or recommended minimum fund balance policies. The financial plan ultimately evaluates the sufficiency of utility revenues in meeting all obligations, including cash uses such as operating expenses, capital outlays, and reserve contributions. The plan also identifies the future adjustments required to fully fund all utility obligations in the projection period.

Section II. AVAILABLE CAPITAL FUNDING ASSISTANCE AND FINANCING RESOURCES

Long-term capital funding strategies must be defined to ensure that adequate resources are available to fund the CIP identified in this Master Plan. In addition to City resources, capital needs can be met from outside sources such as grants, low-interest loans, and bond financing. The following summarizes internal and external resources available for meeting funding requirements.

CITY RESOURCES

Resources appropriate and available to the City for funding capital needs are limited to rate revenues and accumulated cash (through rates and interest) beyond what is required by the minimum reserve requirements set forth in fiscal policies. The City does not maintain specific capital-related charges such as a General Facilities Charge (GFC) that would provide additional capital resources.

OUTSIDE RESOURCES

Although the City does not have additional internal funding sources, there are grant, loan, and bond opportunities available to fund the CIP identified.

Grants and Low Cost Loans

Historically, Federal and State grant programs assist local utilities for funding capital projects. However, these assistance programs have been mostly eliminated, reduced, or replaced by loan programs. Remaining miscellaneous grant programs are generally lightly funding and heavily subscribed. Major funding sources include:

Department of Ecology Grants and Loans

The Washington Department of Ecology (Ecology) administers an integrated funding program for projects that improve and protect water quality throughout the State. The combined funding cycle generally begins September 1, and applicants must submit the final application by the first week of November. Ecology rates and ranks applications based on the highest-priority needs. Projects include stormwater control and treatment, nonpoint pollution abatement and stream restoration activities, and water quality education and outreach. The amount of available grant and loan funding varies from year to year based on the state's biennial budget appropriation process and the annual congressional federal budget. The sources of funding for water quality projects include:

- Centennial Clean Water Fund State Grant Program
- Clean Water Act Section 319 Federal Grant Program
- Clean Water State Revolving Fund (CWSRF) Loan Program
- Stormwater Financial Assistance Program (SFAP)

Further detail is available at <http://www.ecy.wa.gov>. The City has received SFAP funding in the past and anticipates further funds from this program in 2018.

King County Flood Reduction Grant¹

King County's Flood Reduction Grants assist local flood reduction projects. Eligible applicants include cities within King County. Applications are generally due in May there is no cap on the award amount. Total available funding for 2017 was slightly over \$3 million.

For more information see <http://www.kingcountyfloodcontrol.org/default.aspx?ID=62>.

Public Works Trust Fund (PWTF)

Cities, counties, special purpose districts, public utility districts, and quasi-municipal governments are eligible to receive loans from the PWTF. Eligible projects include repair, replacement, and construction of infrastructure for domestic water, sanitary sewer, stormwater, solid waste, road, and bridge projects that improve public health and safety, respond to environmental issues, promote economic development, or upgrade system performance. As of August 2017, the PWTF is not funded through 2019 and is not accepting funding requests.

Further detail is available at <http://www.pwb.wa.gov>.

Bond Financing

General Obligation Bonds

General Obligation (G.O.) bonds are bonds secured by the full faith and credit of the issuing agency, committing all available tax and revenue resources to debt repayment. With this high level of commitment, G.O. bonds have relatively low interest rates and few financial restrictions. However, the authority to issue G.O. bonds is restricted in terms of the amount and use of the funds, as defined

¹ For more information see <http://www.kingcountyfloodcontrol.org/default.aspx?ID=62>

by Washington constitution and statute. Specifically, the amount of debt that can be issued is linked to assessed valuation.

RCW 39.36.020 states:

“(ii) Counties, cities, and towns are limited to an indebtedness amount not exceeding one and one-half percent of the value of the taxable property in such counties, cities, or towns without the assent of three-fifths of the voters therein voting at an election held for that purpose.

(b) In cases requiring such assent counties, cities, towns, and public hospital districts are limited to a total indebtedness of two and one-half percent of the value of the taxable property therein.”

While bonding capacity can limit availability of G.O. bonds for utility purposes, these can sometimes play a valuable role in project financing. A rate savings may be realized through two avenues: the lower interest rate and related bond costs; and the extension of repayment obligation to all tax-paying properties (not just developed properties) through the ad valorem property tax.

It is also possible to use rate revenues to repay G.O. bonds, while retaining the security of the City's taxing power. This practice would still consume statutory G.O. debt capacity. The current financial forecast does not anticipate issuing G.O. bonds.

Revenue Bonds

Revenue bonds are commonly used to fund utility capital improvements. The debt is secured by the revenues of the issuing utility. With this limited commitment, revenue bonds typically bear higher interest rates than G.O. bonds and also require security conditions related to the maintenance of dedicated reserves (a bond reserve) and financial performance (added bond debt service coverage). The City agrees to satisfy these requirements by resolution as a condition of bond sale.

Revenue bonds can be issued in Washington without a public vote. The current financial forecast anticipates issuing revenue bonds to help fund capital projects starting in 2018.

Section III. FINANCIAL FORECAST

The financial forecast, or revenue requirement analysis, forecasts the amount of annual revenue that needs to be generated by user rates to meet the obligations of the Utility. The analysis incorporates operating revenues, operations and maintenance (O&M) expenses, debt service payments, rate-funded capital needs, and any other identified revenues or expenses related to surface water management.

The objective of the financial forecast is to evaluate the sufficiency of the current level of rates. In addition to annual operating costs, the analysis needs to also include any applicable debt covenant requirements and specific fiscal policies and financial goals of the City.

The resulting findings determine the amount of revenue needed in a given year to meet that year's expected financial obligations. For this analysis, two revenue sufficiency tests have been developed to reflect the financial goals and constraints of the City: cash needs and debt coverage. In order to operate successfully with respect to these goals, both tests of revenue sufficiency must be met.

Cash Test

The cash flow test identifies all known cash requirements for the City in each year of the planning period. Typically these include O&M expenses, debt service payments, depreciation funding or directly funded capital outlays, and any additions to specified reserve balances. The total annual cash needs of the City are then compared to projected cash revenues using the current rate structure. Any projected revenue shortfalls are identified and the rate increases necessary to make up the shortfalls are established.

Coverage Test

The coverage test is based on a commitment made by the City when issuing revenue bonds or certain other forms of long-term debt. Debt service coverage is expressed as a multiplier of the annual revenue bond debt service payment. For example, a 1.0 coverage factor would imply that no additional cushion is required. A 1.25 coverage factor means revenue must be sufficient to pay O&M expenses, annual revenue bond debt service, plus an additional 25 percent of that annual revenue bond debt service. The excess cash flow derived from the added coverage, if any, can be used for any purpose, including funding capital projects. Targeting a higher coverage factor can help the City achieve a better credit rating and provide lower interest rates for future debt issues.

In determining the annual revenue requirement, both the cash and coverage sufficiency test must be met and the test with the greatest deficiency drives the level of needed rate increase in any given year.

CURRENT FINANCIAL STRUCTURE

The City maintains a fund structure and implements financial policies that target management of a financially viable and fiscally responsible stormwater system.

Fiscal Policies

Operating Reserves

Operating reserves are designed to provide a liquidity cushion to ensure that adequate cash working capital will be maintained to deal with significant cash balance fluctuations such as unanticipated cash expenses.

The City's current policy is to maintain a minimum balance of 20% of O&M revenues.

We recommend and the study reflects an O&M reserve minimum balance of 120 days. This higher level of reserves is consistent with the risk maintained by the City from receiving surface water fees twice a year coinciding with the payment of property taxes. If the City were to move to a monthly billing system this reserve target could be reduced.

Capital Reserves

A capital contingency reserve is an amount of cash set aside in case of an emergency should the utility have to make an unexpected capital investment. The reserve also is available for other unanticipated capital needs such as cost overruns. Capital reserves are usually calculated as a percentage of fixed asset cost with industry best practice set at around 1 or 2 percent.

We recommend and the study reflects a capital contingency reserve minimum balance of at least 2% of assets, or approximately \$450,000. The City has not maintained a separate balance for this purpose.

System Reinvestment

System reinvestment funding promotes system integrity through reinvestment in the system. Target system reinvestment funding levels are commonly linked to annual depreciation expense as a measure of the decline in asset value associated with routine use of the system. The specific benchmark used to set system reinvestment funding targets is a matter of policy that must balance various objectives including managing rate impacts, keeping long-term costs down, and promoting "generational equity" (i.e. not excessively burdening current customers with paying for facilities that will serve a larger group of customers in the future).

Due to the levels of planned capital improvements over the next six years, this study does not separately consider the need for additional, dedicated, system reinvestment.

Capital Funding

The City will use a combination of debt proceeds and rate revenue to fund prioritized capital projects. More specifically, the following funding resources are identified as part of the capital funding strategy:

- Accumulated cash reserves over minimum fund balances
- Annual cash from rates available for rate funded capital
- Interest earned from the available fund balance and other miscellaneous capital resources
- Revenue bond proceeds (as necessary)

Debt Management

Policies related to debt management are important as part of a broader utility financial policy structure. The City already successfully utilizes and manages revenue bonds. This financial analysis models a minimum bonded debt coverage test of 1.5.

Financial Assumptions

The financial forecast is developed from 2017 and 2018 budget documents. This forecast is supported by key factors and assumptions used to develop a complete portrayal of the Utility's annual financial obligations. The following is a list of the key revenue and expense factors and assumptions used to develop the baseline financial forecast:

- **Revenue** - Revenue is broken down into two sources: revenue from surface water fees (rate revenue) and miscellaneous (non-rate) revenue. Rate revenues can be adjusted to meet annual revenue requirements. Non-rate revenues are not assumed to escalate as they generally comprise of set grants.
- **Growth** - Rate revenue is escalated based on a 0.1 percent customer growth rate. This is based on actual revenue growth seen by the Utility and consistent with the built out nature of the City.
- **Expenses** - O&M expenses are projected based on the 2017 and 2018 budget documents. Expenses are forecasted to increase by factors relevant to their category including labor cost, benefit costs, general costs, and construction cost. One-time expenses are not escalated and other expenses are manually edited based on improved planning data.

Tax expenses are calculated based on forecasted revenue and prevailing tax rates including the State B&O tax and the City's Utility Tax. Expenses also vary by the management strategies discussed in the next section.
- **Existing Debt** - The City's Surface Water Utility has two sources of existing debt. The first source is a Public Works Trust Fund (PWTF) loan set to be paid in full in 2021. The second is a revenue bond for stormwater pipe replacement set to be completed in 2031.

- **Future Debt** - The capital funding strategy developed for this plan utilizes new revenue bonds to help fund capital needs.
- **Rate Funded Capital** - Funds above the minimum reserve requirements are projected for use in funding capital programs.

Section IV. MANAGEMENT MATRIX

ANALYSIS

The City considered three management strategies in the financial analysis; minimum, proactive, and optimum. Each management strategy reflects a different suite of programs and projects that allow the City to provide varying levels of service to its customers². These varying programs and projects impact forecasted operating and capital costs and thus necessary rate increases.

It is important to note that these three strategies are a change from Utility's current operating scenario. The three management strategies all account for additional operational and capital expenditures that help better align the Utility to its levels of service.

Utilizing management strategies in the financial analysis allows the City to determine the rate impacts of different service levels. Through discussion with City Council, City staff, and community residents, the Proactive strategy was chosen as the recommended management strategy.

MANAGEMENT STRATEGY OPTIONS

Management strategies differ on two levels:

- **Programs** - Programs are operations and maintenance activities meant to enhance or maintain surface water services. The Minimum strategy utilizes the fewest number of programs and the Optimum strategy the most. Each strategy builds on the next so there are no programs in the minimum strategy that are not also in the Proactive strategy and there are no programs in the Proactive strategy missing from the Optimum strategy.
- **Projects** - Projects are capital investments meant to enhance or maintain surface water services. The three management strategies differ in the number of projects that are assumed to take place in the six year planning horizon. Projects not planned in the six year planning period are assumed to occur between 2024 and 2036.

² All management strategies considered allow the City to comply with regulatory requirements

Minimum

The Minimum management strategy is a combination of projects and programs meant to meet the minimum in existing system needs and anticipated new regulatory requirements.

Proactive

The Proactive management strategy adds new high-priority projects and enhanced programs that address high priority long-term needs as well as anticipated new regulatory requirements.

Optimum

The Optimum management strategy adds additional priority projects and programs that focus on enhancements to water quality and aquatic habitat.

MANAGEMENT STRATEGY RESULTS AND SUMMARY

The following table summarizes the annual revenue requirements based on the forecast of revenues, expenditures, fund balances, and fiscal policies for each management strategy.

Table IV-1: Management Strategy Summary

Management Strategy Rate Impact Summary	2017	2018	2019	2020	2021	2022	2023
Minimum							
Proposed Increase	N/A	20.00%	5.00%	5.00%	4.00%	3.00%	3.00%
Resulting Revenue	\$4,488,372	\$ 5,391,433	\$ 5,666,666	\$ 5,955,949	\$ 6,200,381	\$ 6,392,779	\$ 6,591,147
Proactive							
Proposed Increase	N/A	27.00%	15.00%	10.00%	10.00%	5.00%	5.00%
Resulting Revenue	\$4,488,372	\$ 5,705,933	\$ 6,568,35	\$ 7,232,449	\$ 7,963,649	\$ 8,370,193	\$ 8,797,492
Optimum							
Proposed Increase	N/A	42.00%	20.00%	10.00%	8.00%	5.00%	5.00%
Resulting Revenue	\$4,488,372	\$ 6,379,862	\$ 7,663,490	\$ 8,438,269	\$ 9,122,444	\$ 9,588,145	\$ 10,077,620

With the greatest number of programs and projects, the Optimum strategy has the highest annual revenue requirements and thus the largest rate adjustment of the three scenarios. However, all scenarios require increases in annual revenue to meet new, required, expenses as they relate to meeting regulatory requirements and appropriately managing the system.

In all three scenarios, an initial, larger, revenue increase is required in 2018 followed by subsequent smaller increases over the next five years. This is due to increases in operations and maintenance expenses to meet regulatory and basic management requirements for operating the Utility.

These expenses cannot be funded through debt and thus the rate impact cannot be spread out over time. The project team has taken effort to spread costs and delay projects where possible to mitigate initial rate impacts and this is reflected in the above results.

Staff recommends the Proactive management strategy. This strategy allows the City to not only be compliant with permit requirements but also attend to pressing investment needs. The next section goes into detail regarding the recommended funding plan for the Proactive strategy.

Section V. RECOMMENDED FUNDING

PLAN (PROACTIVE)

PLAN SUMMARY

The Proactive management strategy includes program and project investments to meet regulatory requirements and address high priority long-term needs of the Utility. There are over \$19.5 million in identified capital project costs (in unescalated 2017 dollars) over the six year planning horizon. Projects and costs include:

Table V-1: CIP Cost Summary for Proactive Management Strategy

Project Name	Total CIP Cost from 2018 – 2023 (in 2017 \$)
Annual CIP Expenses and Programs	
Surface Water Capital Engineering	\$ 1,146,600
Cost Allocation Charges	\$ 1,199,754
Stormwater Pipe Replacement Program (Enhanced)	\$ 3,814,495
Surface Water Small Projects (Enhanced)	\$ 2,400,000
Capacity	
25th Avenue NE Flood Reduction and NE 195th Street Culvert Replacement Design	\$ 2,674,000
Springdale Ct. NW and Ridgefield Rd. Drainage Improvements	\$ 545,000
10th Ave NE Stormwater Improvements	\$ 1,788,000
Heron Creek Culvert Crossing at Springdale Ct. NW	\$ 226,000
25th Ave NE Ditch Improvements Between NE 177th and 178th Street	\$ 141,000
6th Ave NE and NE 200th St Flood Reduction Project	\$ 22,000
NE 148th Street Infiltration Facilities	\$ 393,000
Stormwater Upgrades NW 196th Street	(delayed past 2023)
NW 195th Place and Richmond Beach Drive Flooding	\$ 747,000
Stabilize NW 16th Place Storm Drainage in Reserve M	\$ 28,000
Flood Reduction in Linden Avenue Neighborhood	(delayed past 2023)
Culvert Improvements Near 14849 12th Avenue NE	(delayed past 2023)
18th Avenue NW and NW 204th Drainage System Connection	\$ 15,000
NW 197th Pl and 15th Ave NW Flooding	\$ 7,000

Project Name	Total CIP Cost from 2018 – 2023 (in 2017 \$)
Lack of System and Ponding on 20th Avenue NW	\$ 81,000
26th Avenue NE Flooding and Lack of System Study	(delayed past 2023)
NE 192nd St Ditch Modifications	(delayed past 2023)
NW 194th Place and 25th Ave NW Ditch Erosion	(delayed past 2023)
Repair and Replacement	
Hidden Lake Dam Removal	\$ 2,097,000
Pump Station 26 Improvements	\$ 320,000
Pump Station 30 Upgrades	\$ 90,000
Pump Station Misc Improvements	\$ 732,000
NW 196th Place and 21st Avenue NW Infrastructure Improvements	\$ 83,000
NE 177th Street Drainage Improvements	\$ 9,000
NW 180th and 8th Avenue Ditch with Unknown Connection	(delayed past 2023)
Other	
Master Plan Update	\$ 500,000
Boeing Creek Regional Stormwater Facility	\$ 83,000
System Capacity Modeling Study	\$ 300,000
Storm Creek Erosion Management Study	\$ 80,000
Climate Impacts and Resiliency Study	\$ 80,000
Convert Stormwater Conveyance Ditches to Bio-infiltration Facilities	(delayed past 2023)
Boeing Creek Restoration Pre-design Feasibility Study	\$ 50,000
Echo Lake Biofiltration Swale	(delayed past 2023)
12th Ave NE Infiltration Pond Retrofits	\$ 38,000
Bioretention at N 199th St and Wallingford Avenue NE	(delayed past 2023)
Bioretention at NE 192nd St and Burke Ave NE	(delayed past 2023)
Hamlin Creek Daylighting	(delayed past 2023)
Thornton Creek Course-Grained Sediment Improvements	(delayed past 2023)
Enhance Ronald Bog Wetland Fringe Areas	(delayed past 2023)
Westminster Triangle Bioinfiltration Facility	(delayed past 2023)
Total for 2018 – 2023	\$ 19,689,849

The costs from **Table V-1** shows unescalated project costs. All costs are escalated to the projected year of construction in the analysis. Four projects are delayed past the planning period but may occur sometime after 2023. “CIP Related Expenses” reflect general costs to providing the CIP program and include ongoing system investment such as the “Stormwater Pipe Replacement Program”. “Current Improvement Projects” are projects already listed in prior versions of the City’s CIP. “New Improvement Projects” reflect work identified as part of the updated master planning process.

These total costs are spread over each year depending on the size of the project and the project phase. The below table shows total CIP costs by year in 2017 and inflated values.

Table V-2: Capital Costs by Year

Year	2017 \$	Inflated \$
2018	\$ 1,575,518	\$ 1,622,784
2019	2,521,323	2,674,872
2020	3,096,062	3,383,150
2021	3,170,456	3,568,377
2022	2,853,565	3,308,064
2023	6,472,925	7,729,011
Subtotal	\$ 19,689,849	\$ 22,286,257
2024 – 2036	58,616,342	86,134,881
Total 2018 – 2036	\$ 78,306,191	\$ 108,421,138

In addition to updated CIP costs, the Proactive management strategy contains a number of programs that impact operating costs.

Table V-3: Additional Programmatic Operational Costs for Proactive Management Strategy

Proactive Management Strategy (Escalated Program Costs)	2018	2019	2020	2021	2022	2023
Aquatic Habitat Studies (Not Funded)						
Catch Basin Repair and Replacement	\$ 354,100	\$ 54,100	\$ 354,100	\$ 354,100	\$ 354,100	\$ 354,100
Pump Station Maintenance	63,600	63,600	63,600	63,600	63,600	63,600
LID Maintenance	53,732	53,732	53,732	53,732	53,732	53,732
Utility Crossing Removal	18,400	18,400	18,400	18,400	18,400	18,400
Improper Connection Repair (Not Funded)						
Pipe Condition Assessment Program	160,340	160,340	160,340	160,340	160,340	160,340
Asset Management Program (Enhanced)	69,200	69,200	69,200	69,200	69,200	69,200
Private Facility Inspection and Maintenance (Enhanced)	62,192	62,192	57,341	52,868	48,745	44,943
System Inspection (Enhanced)	47,021	47,021	47,021	47,021	47,021	47,021
Drainage Assessment (Enhanced)	175,640	175,640	175,640	175,640	175,640	175,640
Stormwater Permit	47,840	47,840	47,840	47,840	47,840	47,840
NPDES Compliance (Enhanced)			32,480	32,480	32,480	32,480
Thornton Creek Stewardship (Not Funded)						
Business Inspection Source Control			86,780	86,780	86,780	86,780
Water Quality Monitoring (Enhanced)	85,470	85,470	85,470	85,470	85,470	85,470
O&M for Proactive CIP	33,867	33,867	33,867	33,867	33,867	33,867
Total Unescalated Program Expenditures:	1,171,402	1,171,402	1,285,811	1,281,338	1,277,215	1,273,412
Total Escalated Program Expenditures	1,200,687	1,230,704	1,384,678	1,414,358	1,445,051	1,476,768
Total Escalated Remaining O&M Expenses	3,579,659	3,661,954	3,742,840	4,023,316	4,115,923	4,211,053
Total O&M Expenditures (Escalated)	\$4,780,346	\$4,892,658	\$5,127,517	\$5,437,674	\$5,560,974	\$5,687,821

These programs, as identified in **Table V-3**, are in addition to existing O&M expenses that increase over time at varying rates. The Proactive management strategy's programs initially add over 30% to baseline O&M costs. These additional programs cannot be financed through debt, increasing initial rate adjustment requirements.

CAPITAL FINANCING STRATEGY

The capital costs described in **Table V-2** are funded via a mix of fund balances (above minimum requirements), debt, and approved grants. Since it costs the City money and time to issue debt, a debt issuance strategy of only issuing debt once every three years (as necessary) is used. This is a more realistic methodology than issuing debt every year. Grant funding is not assumed unless it is already approved. Thus, grant funding plays a small role in overall capital financing though it may have a larger role if future grants are received.

Table V-4: Capital Financing Summary

Capital Fund Summary	2018	2019	2020	2021	2022	2023
Funds Available for Capital	\$ 1,207,123	\$ 4,821,000	\$2,486,142	\$ 584,362	\$ 9,323,518	\$ 7,163,005
Capital Revenues:						
Operating Surplus	-	315,909	1,468,939	454,610	1,100,934	1,376,809
Grants / Outside Sources	530,625	-	-	-	-	-
Net Debt Proceeds Available	4,700,000	-	-	11,850,000	-	-
Interest Earnings	<u>6,036</u>	<u>24,105</u>	<u>12,431</u>	<u>2,922</u>	<u>46,618</u>	<u>35,815</u>
Total Capital Revenues and Available Funds	\$ 6,443,784	\$ 5,161,014	\$ 3,967,512	\$ 12,891,894	\$ 10,471,070	\$ 8,575,629
<i>Capital Project Expenditures</i>	<i>\$(1,622,784)</i>	<i>\$(2,674,872)</i>	<i>\$(3,383,150)</i>	<i>\$(3,568,377)</i>	<i>\$(3,308,064)</i>	<i>\$(7,729,011)</i>
Ending Capital Balance	\$ 4,821,000	\$ 2,486,142	\$ 584,362	\$ 9,323,518	\$ 7,163,005	\$ 846,618
<i>Minimum Target</i>	<i>\$ 463,258</i>	<i>\$ 516,755</i>	<i>\$ 584,418</i>	<i>\$ 655,786</i>	<i>\$ 721,947</i>	<i>\$ 876,264</i>

Table V-4 shows the balance between grants, funds, and debt for financing capital projects. Since the City does not have separate funds for Capital and Operating expenses, the “Funds Available for Capital” at the top of the table is not reflective of the total fund balance available to the City. Rather, it is reflective of the available Capital funds after appropriate operations reserves are taken out.

The “Minimum Target” at the bottom of the table reflects the capital reserve target discussed earlier of 2% of assets. Debt issuances and the use of fund balances reflects a strategy to smooth rate increases, reduce the number of debt issuances, and balance the use of debt and rate funding for capital projects.

The capital financing strategy shows two necessary debt issuances; one in 2018 of \$4.7 million and one in 2021 of \$11 million. After these debt issuances, there is an influx of available funds for use in capital projects. These funds are reduced until the next debt issuance. By the end of the planning period (2023), remaining balances are approximately equal to the minimum target of 2% asset value.

FUNDS AND RESERVES

The issuance of additional debt in 2018 and 2021 increases annual debt service payments. It also adds a reserve funding requirement for the new debt. Increased rate revenue to cover new and increasing operational and capital expenditures increases the tax burden on the Utility. As shown in **Table V-5**, this leads to an overall operational cash requirement (outside of Capital requirements) that begins at \$5.8 million in 2018 and grows to over \$9.3 million in 2023.

Table V-5: Funds and Reserves Analysis

Total Expenses and Transfers	2018	2019	2020	2021	2022	2023
Cash Operating Expenses	\$4,780,346	\$4,892,658	\$5,127,517	\$5,437,674	\$5,560,974	\$5,687,821
Existing Debt Service	491,355	489,724	488,091	486,459	158,351	158,351
New Debt Service	377,376	377,376	377,376	1,328,845	1,328,845	1,328,845
Additional Taxes After Rate Increase	90,980	155,327	204,795	259,297	289,450	321,159
Transfer of Surplus to Capital	-	315,909	1,468,939	454,610	1,100,934	1,376,809
Total Cash Requirement	\$5,740,058	\$6,230,994	\$7,666,719	\$7,966,886	\$8,438,555	\$8,872,985

The additional operational costs and capital investments also increase the relative reserve requirements for the Utility. These are shown in **Table V-6** alongside the ending fund balance for each year. Fund balances increase with the issuance of debt (years 2018 and 2021) but fall towards minimum balances as funds are used for capital projects.

Table V-6: Fund Balance Analysis

	2018	2019	2020	2021	2022	2023
Operating Reserve (120 – 150 Days O&M)	\$1,571,621	\$1,638,457	\$1,736,826	\$1,855,058	\$1,913,514	\$1,965,130
Capital Reserve (2% Asset Value)	463,258	516,755	584,418	661,571	724,753	876,264
New Debt Reserve Requirement	377,376	377,376	377,376	1,328,845	1,328,845	1,328,845
Total Fund Balance Requirement	\$2,412,255	\$2,532,588	\$2,698,620	\$3,845,474	\$3,967,112	\$4,170,239
Beginning Fund Balance	\$3,090,142	\$6,788,321	\$4,911,589	\$3,650,033	\$12,507,421	\$10,405,365
Operating Revenues	5,824,359	6,689,119	7,355,474	8,085,118	8,497,011	8,924,602
Cap. Rev. (Grants, New Debt, Interest)	5,236,661	24,105	12,431	11,852,922	46,618	35,815
Less Operating Expenditures	(5,740,058)	(5,915,085)	(6,197,779)	(7,512,275)	(7,337,621)	(7,496,177)
Less Capital Expenditures	(1,622,784)	(2,674,872)	(3,383,150)	(3,568,377)	(3,308,064)	(7,729,011)
Available Ending Fund Balance	\$6,788,321	\$4,911,589	\$2,698,564	\$12,507,421	\$10,405,365	\$4,140,593

Section VI. CURRENT AND PROJECTED RATES

Analysis shows the need for rate increases in the Proactive management strategy as follows.

Table VI-1: Projected Percentage Rate Increases

Rate Increase Summary	2017	2018	2019	2020	2021	2022	2023
Annual Rate Increases		27.0%	15.0%	10.0%	10.0%	5.0%	5.0%
Cumulative Rate Increases		27.0%	46.1%	60.7%	76.7%	85.6%	94.8%
Single Family Annual Bill	\$ 168.81	\$ 214.38	\$246.54	\$ 271.19	\$ 298.31	\$ 313.23	\$ 328.89
Increase over prior year		\$ 45.58	\$ 32.16	\$ 24.65	\$ 27.12	\$ 14.92	\$ 15.66

Table VI-1 reflects the need for the highest increase in 2018 with gradually smaller increases in later years. For single family residences, this reflects an increase in the annual surface water charge from \$168.81 in 2017 to \$347.95 by 2023.

The complete, updated, rate schedule by year reflects the same percentage increases for every customer type.

Table VI-2: Recommended Rate Schedule

Recommended Rate Schedule		Existing w/ Tax						
		2017	2018	2019	2020	2021	2022	2023
<u>Service Charge:</u>	<u>Unit</u>							
Single Family Residential	Parcel	\$168.81	\$214.38	\$246.54	\$271.19	\$298.31	\$313.23	\$328.89
Very Light	Parcel	168.81	214.38	246.54	271.19	298.31	313.23	328.89
Light	Acre	392.06	497.92	572.61	629.87	692.85	727.50	763.87
Moderate	Acre	809.98	1,028.67	1,182.97	1,301.27	1,431.40	1,502.97	1,578.11
Moderately Heavy	Acre	1,570.94	1,995.10	2,294.36	2,523.80	2,776.18	2,914.98	3,060.73
Heavy	Acre	1,990.22	2,527.58	2,906.72	3,197.39	3,517.13	3,692.99	3,877.64
Very Heavy	Acre	2,606.90	3,310.76	3,807.38	4,188.12	4,606.93	4,837.27	5,079.14
Minimum Rate	n/a	168.81	214.38	246.54	271.19	298.31	313.23	328.89

VI.A. 2024 – 2036 REVENUE REQUIREMENT DISCUSSION

Capital Improvement estimates show a sustained increase in capital investments from 2024 through 2036. This increase currently results in an average of over \$3 million annually in additional capital expenditures as compared to the current six-year spending average.

If cost estimates remain unchanged, the City may require higher rate increases in 2024 and 2025 (12% and 9% respectively) before gradually reducing back to inflationary increases. These increases are contingent on the capital costs and schedules remaining as currently estimated.

Section VII. CONCLUSION

The City examined three management strategies in the financial analysis. Each analysis considered all funding resource options, the Utility's financial policies and targets, and current operating needs. All strategies were developed such that they comply with permit obligations.

The Proactive strategy adds new, high-priority, projects and programs and is the recommended management strategy.

All management strategies require rate increases; in particular a higher increase in 2018 followed by smaller increases through 2023. These increases are related to higher O&M obligations of new programs. The Proactive management strategy is recommended because it meets permit obligations and funds many high-priority needs but does not require the same level of investment as the Optimum strategy.

It is important that the City revisit the proposed rates annually to ensure that the rate projections developed remain adequate. Any significant changes should be incorporated into the financial plan and future rates should be adjusted as needed.

The City should take extra consideration of improved capital cost estimates and scheduling in the 2024 – 2036 planning period. While the current rate forecast plans for an increase in capital expenditures through this period, changes to costs and schedules will be important to incorporate.

RECOMMENDATIONS

- Adopt rate structure presented for the Proactive management strategy
- Revise City “CIP Model” to include updated reserve requirements including:
 - 120 days of O&M expenses minimum operating reserve balance
 - 2% of assets minimum capital reserve balance
- Review rates and current operational and capital needs annually
 - This is especially important due to the planned implementation of asset management strategies that may lower operating costs
- Conduct new financial analysis in five years to assure projected rates are in line with Utility expenses

Section VIII. APPENDIX A: RATE MODEL RESULTS

City of Shoreline

Utility Rate Study: Stormwater

Summary - Draft Results (showing Proactive Management Strategy)

High Level Summary	2017	2018	2019	2020	2021	2022	2023
Annual Rate Increases	0.00%	27.00%	15.00%	10.00%	10.00%	5.00%	5.00%
Operating Fund							
Beginning Balance	\$ 1,200,000	\$ 1,505,644	\$ 1,589,945	\$ 2,048,071	\$ 1,736,826	\$ 1,855,058	\$ 1,913,514
Total Operating Revenues	4,655,270	5,824,359	6,689,119	7,355,474	8,085,118	8,497,011	8,924,602
Total Operating Expenditures & System Reinvestn	(4,156,721)	(5,740,058)	(5,915,085)	(6,197,779)	(7,512,275)	(7,337,621)	(7,496,177)
Operating Surplus: Transfers to Capital Fund	(192,906)	-	(315,909)	(1,468,939)	(454,610)	(1,100,934)	(1,376,809)
Cash Surplus / (Deficiency)	305,644	84,302	458,125	(311,245)	118,233	58,456	51,616
Ending Fund Balance	\$ 1,505,644	\$ 1,589,945	\$ 2,048,071	\$ 1,736,826	\$ 1,855,058	\$ 1,913,514	\$ 1,965,130
Capital Fund							
Beginning Balance	\$ 2,280,660	\$ 1,207,123	\$ 4,821,000	\$ 2,486,142	\$ 584,362	\$ 9,323,518	\$ 7,163,005
Total Capital Inflows	686,309	5,236,661	340,014	1,481,370	12,307,532	1,147,552	1,412,624
Total Capital Expenditures	(1,759,846)	(1,622,784)	(2,674,872)	(3,383,150)	(3,568,377)	(3,308,064)	(7,729,011)
Cash Surplus / (Deficiency)	(1,073,537)	3,613,877	(2,334,858)	(1,901,780)	8,739,155	(2,160,512)	(6,316,387)
Ending Fund Balance	\$ 1,207,123	\$ 4,821,000	\$ 2,486,142	\$ 584,362	\$ 9,323,518	\$ 7,163,005	\$ 846,618
	-	-	-	-	-	-	-
	-	-	-	-	-	-	-

City of Shoreline

Utility Rate Study: Stormwater

Summary - Draft Results (showing Proactive Management Strategy)

Operating Fund Summary	2017	2018	2019	2020	2021	2022	2023
Summary of Existing Operations Before Rate Increases							
Rate Revenues Under Existing Rates	\$ 4,488,372	\$ 4,492,861	\$ 4,497,354	\$ 4,501,851	\$ 4,506,353	\$ 4,510,859	\$ 4,515,370
Non-Rate Revenues	<u>166,898</u>	<u>118,426</u>	<u>120,735</u>	<u>123,025</u>	<u>121,469</u>	<u>126,818</u>	<u>127,110</u>
Total Revenues	4,655,270	4,611,287	4,618,088	4,624,876	4,627,822	4,637,677	4,642,480
Total Expenditures	(4,156,721)	(5,649,077)	(5,759,758)	(5,992,985)	(7,252,978)	(7,048,171)	(7,175,017)
Cash Surplus / (Deficiency)	\$ 498,549	\$ (1,037,790)	\$ (1,141,670)	\$ (1,368,108)	\$ (2,625,156)	\$ (2,410,494)	\$ (2,532,538)
Revenues After Rate Increases							
Rate Revenues (Before Rate Increases)	\$ 4,488,372	\$ 4,492,861	\$ 4,497,354	\$ 4,501,851	\$ 4,506,353	\$ 4,510,859	\$ 4,515,370
Additional Revenue from Rate Increases	-	1,213,072	2,071,031	2,730,598	3,457,296	3,859,334	4,282,122
Other Revenues & Interest	<u>166,898</u>	<u>118,426</u>	<u>120,735</u>	<u>123,025</u>	<u>121,469</u>	<u>126,818</u>	<u>127,110</u>
Total Revenues With Rate Increases	\$ 4,655,270	\$ 5,824,359	\$ 6,689,119	\$ 7,355,474	\$ 8,085,118	\$ 8,497,011	\$ 8,924,602
Expenses & Transfers							
Cash Operating Expenses	\$ 3,663,733	\$ 4,780,346	\$ 4,892,658	\$ 5,127,517	\$ 5,437,674	\$ 5,560,974	\$ 5,687,821
Existing Debt Service	492,988	491,355	489,724	488,091	486,459	158,351	158,351
New Debt Service	-	377,376	377,376	377,376	1,328,845	1,328,845	1,328,845
Additional Taxes After Rate Increase	-	90,980	155,327	204,795	259,297	289,450	321,159
Transfer of Surplus to Capital	<u>192,906</u>	<u>-</u>	<u>315,909</u>	<u>1,468,939</u>	<u>454,610</u>	<u>1,100,934</u>	<u>1,376,809</u>
Total Expenses	\$ 4,349,627	\$ 5,740,058	\$ 6,230,994	\$ 7,666,719	\$ 7,966,886	\$ 8,438,555	\$ 8,872,985
Additions / (Subtractions) to Operating Fund Bal	305,644	84,302	458,125	(311,245)	118,233	58,456	51,616
Impacts to Operating Fund Balance							
Beginning Operating Balance	\$ 1,200,000	\$ 1,505,644	\$ 1,589,945	\$ 2,048,071	\$ 1,736,826	\$ 1,855,058	\$ 1,913,514
Net Cash Flow After Transfers to Capital	<u>305,644</u>	<u>84,302</u>	<u>458,125</u>	<u>(311,245)</u>	<u>118,233</u>	<u>58,456</u>	<u>51,616</u>
Ending Operating Balance	\$ 1,505,644	\$ 1,589,945	\$ 2,048,071	\$ 1,736,826	\$ 1,855,058	\$ 1,913,514	\$ 1,965,130
<i>Minimum Operating Balance Target</i>	<i>\$ 1,204,515</i>	<i>\$ 1,571,621</i>	<i>\$ 1,638,457</i>	<i>\$ 1,736,826</i>	<i>\$ 1,855,058</i>	<i>\$ 1,913,514</i>	<i>\$ 1,965,130</i>
Net Cash Flow After Rate Increase	498,549	84,302	774,034	1,157,694	572,843	1,159,390	1,428,425
Coverage After Rate Increase: Bonded Debt	6.33	1.79	3.11	3.80	1.61	1.81	1.98
Coverage After Rate Increase: Total Debt	2.03	1.10	1.92	2.35	1.32	1.81	1.98
Sample Residential Monthly Bill [a]	\$168.81	\$ 227.25	\$ 261.33	\$ 287.47	\$ 316.21	\$ 332.02	\$ 348.62
<i>[a] Including City Utility Tax</i>							

City of Shoreline

Utility Rate Study: Stormwater

Summary - Draft Results (showing Proactive Management Strategy)

Capital Fund Summary	2017	2018	2019	2020	2021	2022	2023
Beginning Capital Balance	\$ 2,280,660	\$ 1,207,123	\$ 4,821,000	\$ 2,486,142	\$ 584,362	\$ 9,323,518	\$ 7,163,005
Capital Revenues:							
Rate Funded System Reinvestment							
Minimum Policy	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Operating Surplus	192,906	-	315,909	1,468,939	454,610	1,100,934	1,376,809
Total	\$ 192,906	\$ -	\$ 315,909	\$ 1,468,939	\$ 454,610	\$ 1,100,934	\$ 1,376,809
Grants / Outside Sources	482,000	530,625	-	-	-	-	-
Net Debt Proceeds Available for Projects	-	4,700,000	-	-	11,850,000	-	-
Interest Earnings	11,403	6,036	24,105	12,431	2,922	46,618	35,815
Total Capital Revenues and Beginning Fund Bal:	\$ 2,966,969	\$ 6,443,784	\$ 5,161,014	\$ 3,967,512	\$ 12,891,894	\$ 10,471,070	\$ 8,575,629
Capital Project Expenditures	\$ (1,759,846)	\$ (1,622,784)	\$ (2,674,872)	\$ (3,383,150)	\$ (3,568,377)	\$ (3,308,064)	\$ (7,729,011)
Ending Capital Balance	\$ 1,207,123	\$ 4,821,000	\$ 2,486,142	\$ 584,362	\$ 9,323,518	\$ 7,163,005	\$ 846,618
<i>Minimum Target</i>	<i>\$ 430,802</i>	<i>\$ 463,258</i>	<i>\$ 516,755</i>	<i>\$ 584,418</i>	<i>\$ 655,786</i>	<i>\$ 721,947</i>	<i>\$ 876,527</i>

Ending Fund Balances	2017	2018	2019	2020	2021	2022	2023
Operating Fund	\$ 1,505,644	\$ 1,589,945	\$ 2,048,071	\$ 1,736,826	\$ 1,855,058	\$ 1,913,514	\$ 1,965,130
Capital Fund	1,207,123	4,821,000	2,486,142	584,362	9,323,518	7,163,005	846,618
Debt Reserve Fund	-	377,376	377,376	377,376	1,328,845	1,328,845	1,328,845
	\$ 2,712,766	\$ 6,788,321	\$ 4,911,589	\$ 2,698,564	\$ 12,507,421	\$ 10,405,365	\$ 4,140,593
Operating Reserve: Minimum Days of O&M	120 days	120 days	120 days	120 days	120 days	120 days	120 days
Operating Reserve: Actual Days of O&M	150 days	119 days	148 days	119 days	119 days	119 days	119 days
Capital Fund Minimum Target	\$ 430,802	\$ 463,258	\$ 516,755	\$ 584,418	\$ 655,786	\$ 721,947	\$ 876,527

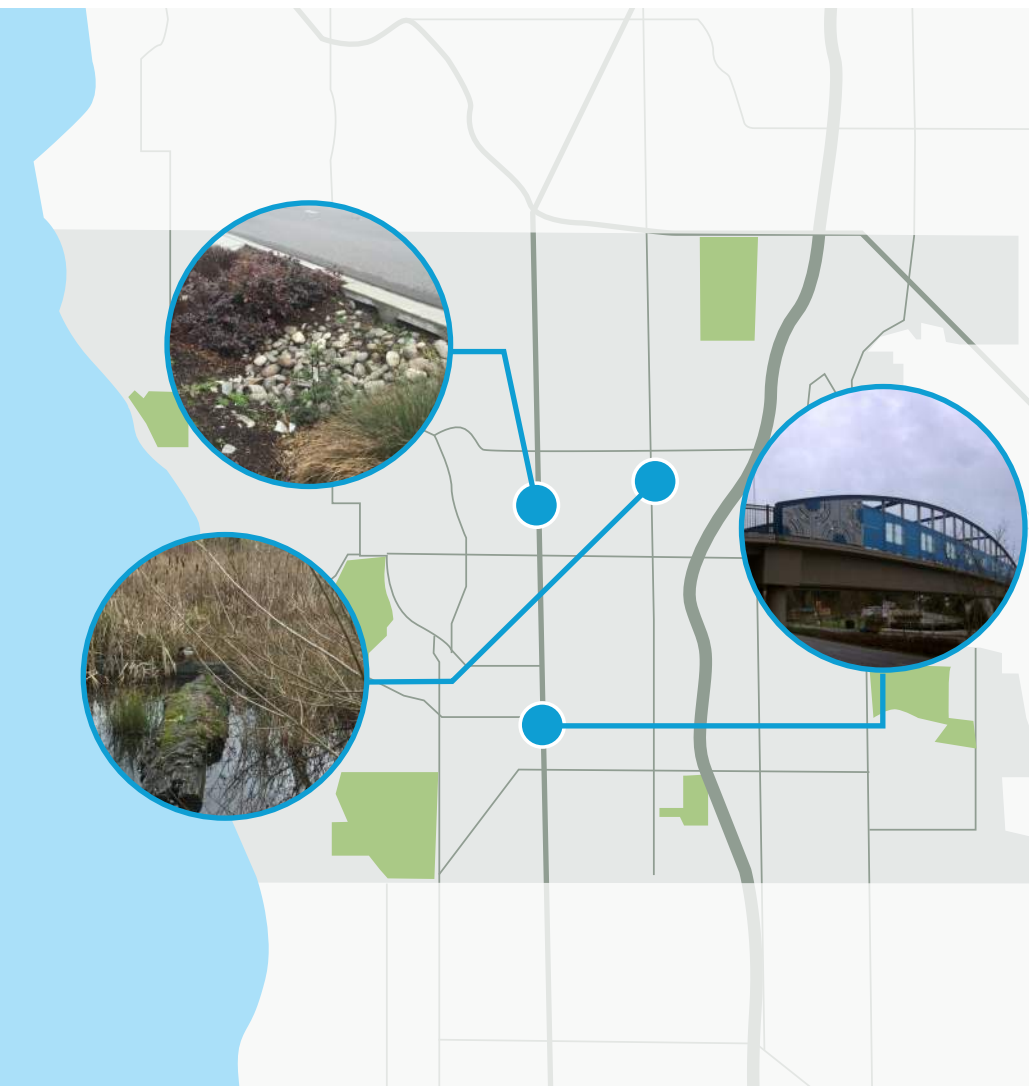
City of Shoreline

Utility Rate Study: Stormwater

Summary - Draft Results (showing Proactive Management Strategy)

Debt Management	2017	2018	2019	2020	2021	2022	2023
Debt Service Coverage							
Bonded Debt	6.33	1.79	3.11	3.80	1.61	1.81	1.98
All Debt	2.03	1.10	1.92	2.35	1.32	1.81	1.98
Debt Service ÷ Rate Revenues	11%	15%	13%	12%	23%	18%	17%
Debt to Fixed Assets	20%	41%	33%	27%	64%	56%	43%
Formula: Outstanding Debt Principal ÷ Book Value of Plant-in-Service (Original Cost - Accumulated Depreciation)							
<u>Outstanding Debt Principal</u>							
Existing Debt Balance	\$ 3,958,848	\$ 3,518,746	\$ 7,603,756	\$ 6,979,284	\$ 6,344,996	\$ 17,116,308	\$ 16,336,207
plus: New Debt Issued	-	4,700,000	-	-	11,850,000	-	-
less Debt Principal Paid Off	\$ (440,103)	\$ (614,989)	\$ (624,472)	\$ (634,288)	\$ (1,078,688)	\$ (780,102)	\$ (809,057)
Total Outstanding Debt Principal	\$ 3,518,746	\$ 7,603,756	\$ 6,979,284	\$ 6,344,996	\$ 17,116,308	\$ 16,336,207	\$ 15,527,149
<u>Book Value</u>							
Book Value	n/a	\$ 17,540,583	\$ 18,681,531	\$ 20,842,348	\$ 23,658,192	\$ 26,591,851	\$ 29,194,264
Original Cost Plant in Service	19,780,260						
Accumulated Depreciation	(3,552,730)						
plus: Capital from CIP	1,759,846	1,622,784	2,674,872	3,383,150	3,568,377	3,308,064	7,729,011
less: Annual depreciation	(446,793)	(481,836)	(514,054)	(567,306)	(634,717)	(705,652)	(771,367)
Original Asset Cost Net of Depreciation	\$ 17,540,583	\$ 18,681,531	\$ 20,842,348	\$ 23,658,192	\$ 26,591,851	\$ 29,194,264	\$ 36,151,907

Rate Increase Summary	2017	2018	2019	2020	2021	2022	2023
Annual Rate Increases		27.0%	15.0%	10.0%	10.0%	5.0%	5.0%
Cumulative Rate Increases		27.0%	46.1%	60.7%	76.7%	85.6%	94.8%
Single Family Annual Bill	\$ 168.81	\$214.38	\$246.54	\$271.19	\$298.31	\$313.23	\$328.89
		\$45.58	\$32.16	\$24.65	\$27.12	\$14.92	\$15.66



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